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TEXT BOOK

VOLUME III

MEDICAL EQUIPMENT - GENERAL

NOVEMBER, 1943

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This publication has not been officially approved by the War Department. It has been prepared and is issued for instructional purposes only.

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CHAPTER I

ELECTRO MEDICAL EQUIPMENT

SECTION I

CONVENTIONAL DIATHERMY

When a direct current passes through a conductor a chemical action is produced. This applies as well when the conductor is human tissue. When an alternating current passes thru living human tissue, a mechanical reaction results. You have all experienced such a reaction.

When the frequency exceeds the range in which neuro muscular response takes place, heat is produced in the tissue by resistance of the tissue to the passage of the high frequency current. The original determination of the phenomenon was made by D'Arsonval, Professor in the college de Paris, France. He worked with frequencies of the order of 5000 per second.

Subsequent experiments with more delicate instruments showed that the limit of muscle stimulation was approximately 250,000 alternations per second. To the frequencies above those producing neuro muscular response, the term high-frequency was applied by Nikola Tesla in 1891. The term diathermy, dia (through) and thermy (to heat) is credited to Nagelschmidt. While frequency is an important factor in diathermy, resistance, inductance, capacity, reactance, and voltage must also be considered. Frequency is dependant upon capacity and inductance.

What is meant by frequency? The number of cycles in a given period of time. Ordinary lighting circuits are 60 cycle. High frequency may vary from 1200 meters to 6 meters or 250,000 cycles to 50,000,000 cycles. Velocity divided by frequency equals wave length. Velocity of electricity is the same as that of light or 300,000,000 meters per second.

The exact path taken by high frequency currents is not definitely known. For effective application the electrodes should be placed so as to offer the current a shorter path thru a part than around it. The distribution of the current will then depend chiefly upon the resistance and position of the tissues.

The three practical methods are:

1. Thru & thru; efficient but not always suitable.
2. Plate and cuff, serviceable for extremities.
3. Double Cuff; inefficient but advantageous in treating knees and elbows.

Contraindications to diathermy:

1. Acute inflammatory processes accompanied by fever.
2. The presence of non-draining suppuration.
3. Tendency to hemorrhage.
4. Suspected malignancy (except when surgically applied).
5. Areas of anesthesia.

Diathermy produces hyperemia.

The effects of Hyperemia:
1. Relief of pain.
2. Bactericidol and bacteria-inhabiting.
3. Resorptive effect.
4. Dissolving effect.
5. Nutritive effect.

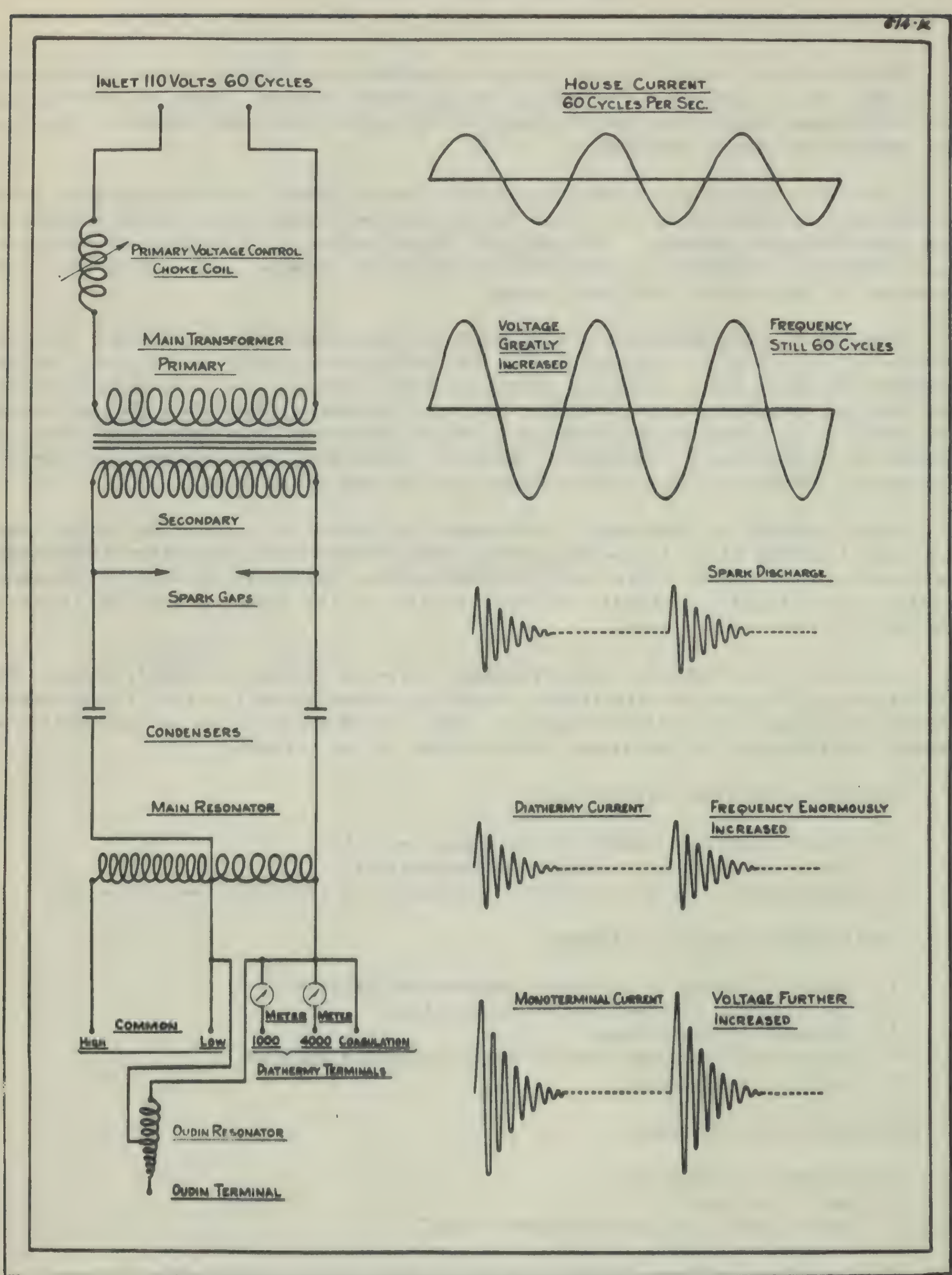

FIG. 124.—Diagram of circuits and oscillations produced in diathermy apparatus of spark-gap type.

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CHAPTER I

ELECTRO MEDICAL EQUIPMENT

SECTION 2

ELECTRO SURGICAL UNITS

ELECTRO-SURGICAL UNITS

INSTRUCTIONS FOR CONNECTING AND OPERATING THE PORTABLE BOVIE ELECTRO-SURGICAL UNITS (4-Gap or 3-Gap Models)

GENERAL DESCRIPTION

NOTE - The accessories and spares are packed in a special compartment in the removable cover of the unit and it will be noted that care must be exercised in repacking these accessories when not in use, in order to fit them all into the space provided.

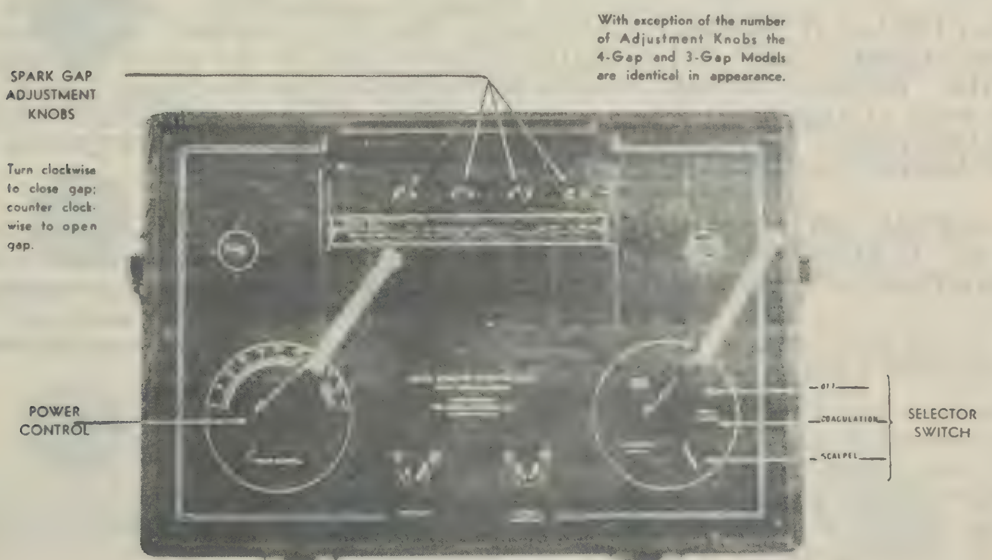
Both Portable Bovies are the same insofar as operation is concerned -- The difference being that the one model has 3 Spark Gaps whereas the other has 4 Spark Gaps and a heavier transformer.

The 4-Gap Model is recommended for major surgery, including under-water cutting, (Prostatic Resection). The 3-Gap Model is not suitable for under-water cutting, but is recommended for all office electro-surgery and for hospital procedures which do not require the greater output of the 4-Gap unit.

NOTICE

The Portable Bovie Unit with which these Instructions are furnished is the Military Model No. 9901-A. The accessories and spares are packed in a special compartment in the removable cover of the unit and it will be noted that care must be exercised in repacking these accessories when not in use, in order to fit them all into the space provided.

This apparatus is designed to operate on either 50 or 60 cycle, 115 or 230 volt, single phase alternating current. When it leaves the factory, it is adjusted so that it is ready for use on 115 volts, 50 or 60 cycle current. If it becomes necessary to use it on 230 volt current, remove the back panel and change the transformer tap connection from the 115 volt to the 230 volt setting. The two terminals are located on a terminal board at the rear and bottom of the cabinet. These connections are plainly marked and it is only necessary to unscrew the thumb nuts, switch the connector from one terminal to the other and replace the thumb nut.



VIEW OF TOP PANEL

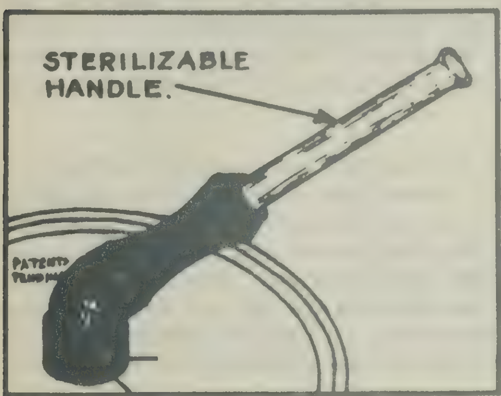
Two distinct high frequency currents are generated:
1 - CUTTING and 2 - COAGULATION.

Either current can be instantly connected to the outlet terminals by simply placing the manually operated Selector Switch in the proper position as illustrated on Page 1.

To the rear of the top panel, beneath the hinged cover, are the spark gap adjustment knobs. Immediately in front of the gap adjustment knobs is the glass window through which the gaps can be seen.

In front of this window, to the left, is a single POWER CONTROL that governs the power of either current. This control, moving through its graduated scale, varies the current strength from zero up to the maximum output.

To the right is the three position SELECTOR SWITCH which also serves as a MAIN SWITCH. When Selector is placed on the "Scalpel" (cutting) or "coagulation" position, the supply current is turned onto the machine, the pilot light glows, and the machine is ready for service, but no high frequency current is generated until the foot switch is depressed.



STERILIZABLE HANDLES - These are provided for the Selector Switch and the Power Control. When the machine is used for major surgery these handles should be sterilized by boiling or auto-claving and inserted in openings to the power control and selector switch, thus permitting all necessary manipulations under aseptic conditions. Two or three clockwise turns will lock sterilizable handle in place.

TERMINALS - At the front of the top panel are two terminals of the plug-in type. The one on the right is marked "Active Electrode". Into this is inserted the Bovie plug on the end of the Chuck Handle cord. The other terminal, on the left, is marked "Patient". Into it is inserted the Bovie plug on the end of the cord with the clip. The clip, in turn, connects to the Patient (or indifferent) metal electrode which is placed in contact with the patient's skin. To prevent connecting these incorrectly, the "Patient" terminal and plug are round and the "Active Electrode" terminal and plug are square.

Near the rear left hand corner is the pilot light which glows when "Current Selector" is placed on "coagulation" or "scalpel". However, as previously noted, no coagulation or cutting current is generated until foot switch is depressed.

On the left side of the cabinet are connections for the electrical current (marked "SUPPLY PLUG") and for the "FOOT SWITCH".

TO PLACE MACHINE IN OPERATION

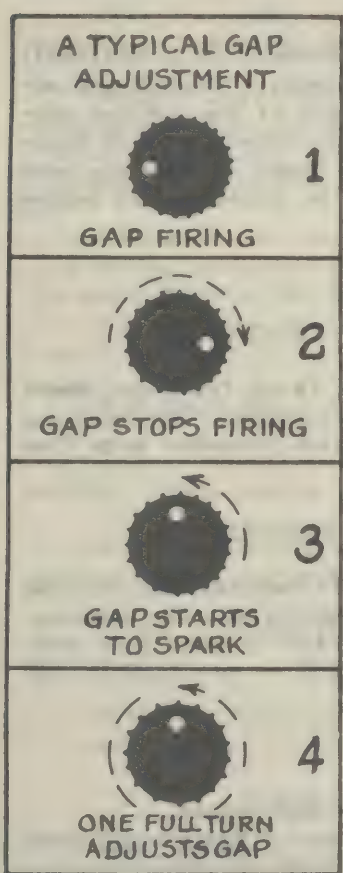
1. Connect Supply Cable and Foot Switch.
2. Adjust Spark Gaps.
3. Connect Indifferent (Patient) Electrode.
4. Connect Chuck Handle (Active Electrode).

To place the Bovie Unit in service requires merely that the supply cable and foot switch be connected, the spark gaps correctly adjusted, the patient and active electrodes connected and the power control properly set. These steps are covered in detail in the following.

1. *Connect supply cable and foot switch* to proper terminals on back of cabinet. Be sure the machine is connected to supply current of proper voltage and frequency. Unless otherwise noted on name plate, the Bovie is designed for operation on 115 volts, 60 cycle alternating current. Special models which operate on other alternating currents are so marked on the name plate. When only direct current is available a rotary converter must be used. Make sure that the fuses on your supply line are heavy enough to carry the machine in addition to any other load that may be on the line at the same time. The Portable Bovies require approximately fourteen amperes at 115 volts. Consult your electrician and see that fuses of adequate capacity are installed before machine is put in use.

2. ADJUST SPARK GAPS - Firing of the gaps may be observed through the glass window. Immediately above each gap is its adjustment knob. Turning the knob *clockwise* closes the gap; counter-clockwise *opens* the gap.

As the quality of the current is dependent on spark gap adjustment, it is essential that this operation be accurately and properly performed. There is nothing difficult about the gap adjustment -- on the contrary, it is a rather simple procedure -- but it must be done just right to insure satisfactory performance.



To adjust gaps, first move Selector Switch to either the "Scalpel" or "Coagulation" position. Step on foot switch to start current flow through gaps. Then look at the gaps through observation window. If any of the gaps are not firing, turn the proper adjusting knob (or knobs) counter-clockwise to open the gaps slightly until all start to fire. It is essential that all gaps be firing prior to adjustment. IF UNABLE TO MAKE ALL GAPS FIRE, SEE FOLLOWING PAGES.

1 - After all gaps are firing, take each individual gap (for example, start at left and work to right), carefully align your eye with the gap being adjusted and

2 - Turn its adjustment knob CLOCKWISE until it stops firing.

3 - Slowly turn knob COUNTER-CLOCKWISE until you see the gap start to spark, THEN STOP. Note position of small white dot on knob.

4 - From the point where continuous sparking was first observed, TURN KNOB COUNTER-CLOCKWISE ONE FULL TURN, which will put that particular gap in proper adjustment.

ADJUST *ALL* GAPS IN THIS MANNER

It is important that the observer's eye be lined up directly with the sparking surface of gap being adjusted. The best way is to close one eye, and moving the head laterally in front of the gap, stop at the point where firing seems most intense. The arc that takes place is quite small and, if viewed from even a moderate angle,

you may not see the first sparking in the gap from which point the subsequent one turn counter-clockwise adjustment must be made.

For best performance the gap adjustment should be made each day before operations are started. While the gaps will, under ordinary conditions, retain their adjustment over quite a period of time, they may get slightly out of adjustment if the machine is moved around or jolted, and for assurance of satisfactory performance we recomment a complete gap adjustment *each day before starting to work.*

When correctly adjusted, intensity of the arc in each gap should appear about the same to the eye. If a particular gap appears to fire with *less intensity* than the others, it probably means that it *has not been opened enough* and should be completely readjusted in accordance with above instructions.

If any one gap fires irregularly or sputters, it very likely means that the gap needs readjustment because it *has been opened too wide.*

With the gaps properly adjusted you will hardly hear the arc that takes place when current is on. (Don't confuse the 60 cycle transformer hum with the high pitched hissing note of the arc.) If one or more of the gaps are opened too wide, or if they are adjusted improperly so that one takes most of the load, there will be a decided sputtering in that one gap (or all gaps, if all are open too much). The sputter can be seen and its crackling sound is distinctly heard. A single sputter at rare intervals is of no consequence, but if heard often or continuously, all gaps should be correctly adjusted.

We have elaborated on this spark gap adjustment, not because it is difficult or complicated, but rather on account of its relative importance. Correct gap adjustment is essential to satisfactory operation, particularly of the cutting current. If the machine seems to lack cutting power - if it cuts slowly - or if there is an excessive amount of dehydrated tissue on edges of the wound - these are sure signs that the gaps are not in adjustment and they should be properly set before further use.

Remember these simple instructions:

HAVE ALL GAPS FIRING BEFORE THE ADJUSTMENT IS STARTED

HAVE THE EYE LINED UP DIRECTLY WITH SPARKING SURFACE - Catch the point where firing first begins. This is a critical factor in the adjustment. You must see the very first twinkle and then open the gap one full counter-clockwise turn *from the point where firing was first observed.*

ADJUST ALL GAPS EACH DAY BEFORE WORK IS STARTED

These Bovie gaps incorporate a unique, patented, self-compensating feature which insures their continuous, satisfactory operation and consistent performance. *When properly adjusted,* the machine is brought to a condition of stability and, under equivalent conditions, results can always be duplicated -- you know in advance the results to be expected from a given power setting.

IF UNABLE TO MAKE GAPS FIRE

1. Make sure that machine is connected to correct current supply.
2. Make sure that the supply line is not "dead" because of burned out fuses or other reasons. Pilot light will glow when machine is connected to proper current

supply and Selector Switch is on the "Scalpel" or "Coagulation" position. If pilot light does not glow, look for trouble in your supply line.

3. See that the foot switch is connected.

4. See that current selector is on "Scalpel" or "Coagulation" position.

5. Occasionally some uninformed persons may start to "play" with the machine and close one or more gaps several turns or open them up a number of turns. If this occurs it may appear impossible to get the gaps to fire. Fortunately, there is a simple remedy for this seemingly perplexing condition.

The thing to do is first, *close* all gaps completely by turning each adjustment knob clockwise until resistance is felt and further motion arrested. This may require anywhere from two to three to thirty or more turns, depending on whether gap is partially open or closed at the start. Stops limit the number of possible turns in either direction and considerable resistance will be felt when this limit is reached. Don't attempt to turn knob BEYOND POINT WHERE RESISTANCE IS FELT. To do so might damage gap mechanism.

After all gaps are completely closed -- after all knobs have been turned clockwise until resistance is felt -- then open *one gap at a time* until it starts firing. This will require from fifteen to twenty-five *counter-clockwise* turns. Then open the other gaps in same manner until *all* are firing. After all gaps have started to fire they should be correctly adjusted in accordance with instructions in preceding section.

With the supply cable and foot switch connected and gaps properly adjusted, the machine is ready for service and you can:

Connect indifferent electrode to the terminal marked "Patient", using the cord with clip on one end and round plug on other. The clip is fastened onto the metal indifferent plate. (See subsequent section for further information on applying indifferent electrode.)

When used for aseptic surgery the various parts that require touching or handling during operation should be sterilized before they are connected. These include the glass handles for Power Control and Selector Handles, the Chuck Handle and cord and the required operation electrodes. (See subsequent section on methods of sterilization.)

With these parts sterilized you are ready to:

Insert sterilizable handles in openings in the power control and selector switch. Turn handle two or three clockwise turns to lock it in place.

Insert operating electrodes in Chuck Handles by unscrewing to release the chuck, inserting the electrode and then tightening chuck carefully.

Connect terminal plug on the Chuck Handle to the terminal marked "Active Electrode".

With all connections made the machine is ready for service with the exception of power control adjustment. This is covered at length in the following section.

POWER CONTROL SETTINGS FOR ELECTRO-CUTTING

The single control at left front on the top panel varies the power of both the cutting and coagulation currents. This control is effective when either current is turned on.

Rotating through its graduated scale, it affords a constant, unbroken range of power from zero up to maximum output of the current in use. The scale is purely arbitrary, indicating the relative current strength between minimum and maximum settings.

The amount of power required for any given type of work -- either cutting or coagulation -- involves a number of variables so that in the end, experience and familiarity with the machine and different electrodes will be of more value than any arbitrary figures we may set. However, if the fundamentals are thoroughly understood, the operator will, with a little experience, have no difficulty in arriving at the correct settings to use under different conditions.

IF MACHINE DOES NOT CUT - The chances for any electrical or mechanical failure on the part of the machine itself are so remote that if, on trail, it apparently will not cut, it is likely that some important point in the preparation has been overlooked. Therefore, in case the machine does not cut properly, check all the following points and *be sure:*

1. That machine is connected to correct current supply.
2. That current supply is alive. Be sure to have fuses of sufficient capacity on your supply wire to carry the Bovie as well as any other load that may be on the line at the same time.
3. That Current Selector is on "SCALPEL" position.
4. That all spark gaps are correctly adjusted and firing with equal intensity, without sputtering or irregular operation.
5. That high frequency cord from operating electrode is connected to the machine.
6. That indifferent electrode is firmly in contact with Patient's bare skin and connected to the machine.
7. That power control is properly set.

CUTTING UNDER WATER WITH 4-GAP MODEL PORTABLE BOVIE - Under-water cutting requires electrodes with insulated shanks so that all current will be concentrated on the cutting area of the electrode. The uninsulated oper-air electrodes will not cut under water because a larger proportion of the cutting current will be dissipated into the water from the bare shank of the electrode.

Therefore, do not expect to cut under-water except with electrodes designed especially for that purpose.

POWER SETTINGS FOR ELECTRO-COAGULATION AND DESICCATION

For this work current is applied by various methods through electrodes of different sizes and shapes so that an understanding of the different conditions is necessary before power settings can be worked out.

Electro-coagulation can be defined as a process in which a high frequency current is employed to actually "cook" tissue surrounding the active electrodes. Enough heat to do this is generated within the tissue by the current passing from the electrode into the surrounding tissue.

Electro-dessiccation is a procedure in which the active electrode is not placed in actual contact with tissue. Current is allowed to jump through space and, sparking onto the surface being treated, dehydrates the superficial layers of tissue.

These two methods of application produce exactly the same effect on tissue - namely - the cells so treated are dehydrated, or coagulated, or, actually cooked -

the difference being that contact coagulation penetrates more deeply, causes a greater depth of destruction - whereas desiccation affects only the superficial layers.

Both coagulation and desiccation can be done with or without an indifferent electrode. To denote these two conditions the following terms are used:

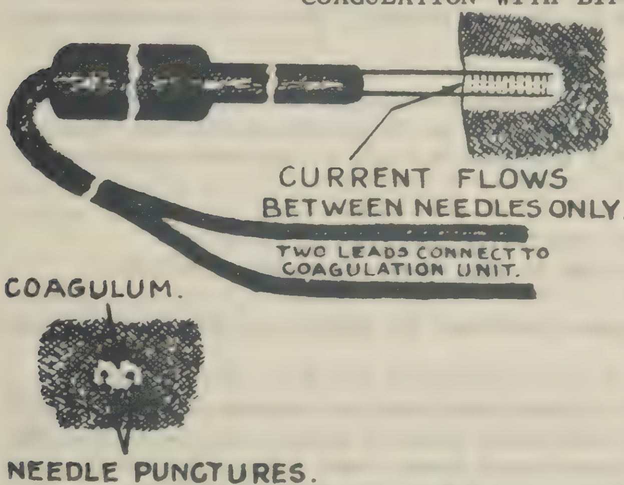
1. *Monopolar* when a single active electrode is used *without* an indifferent electrode.
2. *Bipolar* when an indifferent electrode is used for current return path.

These terms are used merely to indicate the method of applying current. There is no difference in the surgical effect of the current or in their electrical characteristics. The only difference is in the amount of power secured from a given setting. *For a given power setting* more current is obtained with bipolar applications than with monopolar.

The amount of power required for this work varies widely and depends on:
A. Size of Electrode used.
B. Area of electrode in contact with tissue.
C. Depth and area of destruction desired.
D. Length of time current is applied.

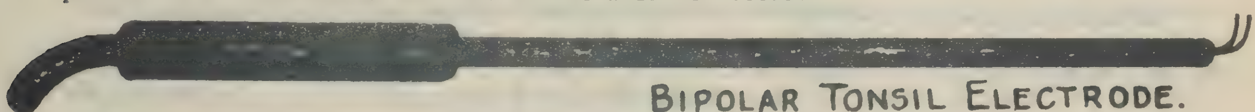
Again it is not possible to give definite power settings for various classes of work, but the following will serve as a starting point.

COAGULATION WITH BIPOLAR ELECTRODES

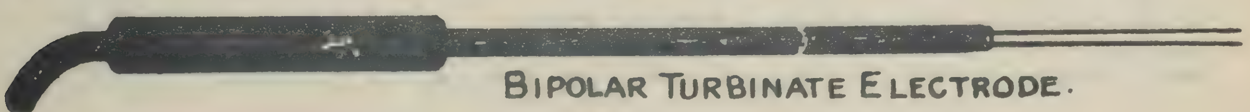


In recent years there has been a steadily increasing use of the so-called bipolar coagulation electrodes. In these instruments there are two needles or points, each connected to one of the terminals on the coagulation machine. No indifferent electrode is used as the two points are each, in effect, active electrodes. Coagulation takes place only between and around the two needles. While made in a variety of designs, the tonsil, cervical, and turbinate electrodes, as illustrated, are the ones most extensively used.

Only a small amount of power is required for bipolar electrodes as the current penetrates only the tissue lying between and immediately around the needles. Extreme care must be taken to avoid an excess of power at that arcing between the points or a breakwown within the handle will not occur.

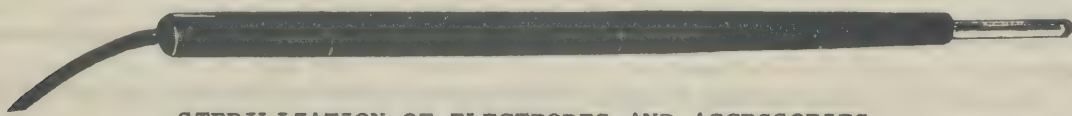


BIPOLAR TONSIL ELECTRODE.



BIPOLAR TURBINATE ELECTRODE.

CHERRY BI-POLAR CERVICAL COAGULATION ELECTRODE - Consists of an insulating tip with two narrow metal plates at each side, which constitute the active electrodes. The tip is passed into the cervical canal, the current turned on and the electrode rotated through one half turn, which results in coagulation of the endocervical tissues - the depth of destruction depending on the amount of current used and speed of rotation.



STERILIZATION OF ELECTRODES AND ACCESSORIES

In preparing the Bovie Unit for aseptic surgery, all parts which are handled or touched in the course of an operation should be sterilized prior to use. These include the operating electrode handles with their cords; the sterilizable handles which fit into power control and selector switch; all needles, knives, loops, blades and other operating instruments.

The metal parts, including the loops, needles, knives, etc., can be sterilized by prolonged boiling or auto-claving without damage.

However, the bakelite handles and rubber cords are subject to some deterioration if subjected to prolonged heat sterilization and they will need replacement from time to time.

The useful life of the handles and cords can be lengthened by sterilization in some adequate cold solution, but we do not recommend cold sterilization in Nuero-Surgery, operation in the Thoracic Cavity, in the abdomen, etc., where immaculate conditions are essential.

In several institutions the operating handles and cords are wrapped in towels and sterilized in the auto-clave for ten minutes at 20 pounds pressure. This is considered adequate for most major surgery and does not cause undue deterioration of the bakelite and rubber parts.

SPECIAL NOTES ON POWER SETTINGS FOR TRANSURETHRAL PROSTATIC RESECTION WITH THE 4-GAP MODEL PORTABLE BOVIE

As in all electro-surgical work, power settings for resection should be varied to best suit the immediate conditions.

It is always desirable to use the least power that will produce the desired results, i.e., use the lowest cutting power that resects freely on the particular gland being removed. Use the lowest coagulation power that will effectively control hemorrhage, remembering that the larger the bleeding vessel, the more power is required for quick control. The less power used, the longer the loops will last and the less tendency to char and carbonize the sheath.

In general, somewhere within the following power ranges will prove satisfactory.

28 Fr. McCarthy Electrotome	- Cutting Power	- 65 to 95
	Coagulation Power	- 50 to 60
24 Fr. McCarthy Electrotome	- Cutting Power	- 60 to 80
	Coagulation Power	- 40 to 50

It may be desirable to change power settings in the course of an operation. When starting to resect it is advisable to use the lower power range and if easier cutting is desired, step up the power a few points at a time until it cuts freely.

For control of hemorrhage a coagulation power setting around 45 will effectively control oozing or bleeding from the smaller vessels, but in the presence of large individual spurters more power (around 55) should be applied for effective, rapid control. Really large bleeders require considerable power for quick control.

STERILIZATION OF RESECTION INSTRUMENTS - For Prostatic Resection instruments the customary mercuric cyanide solution used for cystoscopes is recommended. Alcohol or phenol should not be used on the resection instruments as they may cause deterioration of some of the parts.

IF THE MACHINE DOES NOT CUT - In Prostatic Resection, with all the points checked, if machine still does not cut, it may indicate:

A - A defective loop - change loops immediately, or
B - That the irrigating medium is of high chemical content. If in doubt, only distilled water should be used.

CAUTION

PREVENTION OF HIGH FREQUENCY SKIN BURNS - Burns are possible either from the indifferent electrode (if improperly prepared and applied) or from the active electrode if it is carelessly handled or laid on the patient when not in use.

Edges of the indifferent plate should be turned back on themselves and applied away from the patient's skin. The plate should be rolled flat each time before using (wrinkles, irregularities or sharp points will cause concentration of current and probable burns). To insure good contact, the plate and patient's skin should have a generous application of heavy soap lather or K-Y Jelly and, under no circumstances, should the plate be applied over hair or hard scar tissues. Hair and scar tissue are non-conductive and may cause concentration of current at other points under the electrode.

When not in use, the chuck handle and active electrode should be placed on the sterilizable instrument rack attached to the machine bacause, if laid on top of patient, a burn may result if footswitch is depressed.

PREVENTION OF BURNS RESULTING FROM ACCIDENTAL IGNITION OF INFLAMMABLE FLUIDS - When an inflammable fluid (such as alcohol) is used to cleanse the field preparatory to surgery, it is well to remember that there is possibility of igniting any residual liquid by a spark from the electrode. When inflammable fluids or solvents are used, allow sufficient time for *complete evaporation* and be sure that dressings, coverings, clothing, etc., surrounding the field are not saturated with the liquid.

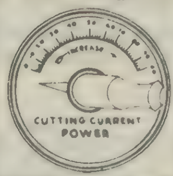
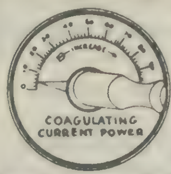
PREVENTION OF EXPLOSION FROM IGNITION OF INFLAMMABLE INHALANT ANAESTHETICS - The use of an electrosurgical machine imposes some limititions on the type of anaesthetics which can be safely used. Choice of anaesthesia should be made with full consideration of the danger of using electrical sparks in the presence of explosive gases.

Some gases, such as ethylene, cyclopropane and vinyl ether, are so explosive in small concentrations that they should *never* be used with electro-surgery. Ether,

Control Settings

FOR TECHNIQUES MOST COMMONLY PERFORMED WITH THE PORTABLE BOVIE

CAUTION: THE PORTABLE BOVIE IS SOLD FOR USE ONLY BY QUALIFIED PHYSICIANS AND SURGEONS

Power settings printed on this sheet are approximate. When accurate preferred settings have been determined, insert them with ink in the spaces provided. ——— All techniques are Bi-polar, i.e., indifferent plate applied to patient.	Cutting 	Coagulating 	Suggestions for Procedure ↓
Prostatic Resection (Recommended with 4-GAP model only)	28 Fr. 65 to 95 24 Fr. 60 to 80	28 Fr. 50 to 60 24 Fr. 40 to 50	See details Page 14 of instructions
Bladder Fulguration	→	45 to 65 Depending on size of tip	Use lowest power sufficient to blanche tissue readily
Electro-Hemostasis	→	30 to 45 Depending on tip or size of hemostat	See booklet "Fundamentals" of Electro-Surgery, pages 26-30
Skin Incisions	25 to 45	←	Use only small flat blade perpendicular to tissue, and cut rapidly.
Muscle Dissection	30 and up	←	Use small or large flat blade..
Fat or Cartilage Dissection	40 to 50	←	Use ONLY small flat blade, cut rapidly.
Stomach, Intestine or Bladder Wall Resection	30 and up	←	Use small or large flat blade.
Incision or Dissection Where Primary Union is NOT Expected	35 and up	←	For maximum hemostatic effect, use large needle, cut slowly
Biopsies	35 to 45	25 to 35	Use small loop
Cervical Conization	40 to 50	30 to 40	See "Conization Technic" accompanying instructions
Massive Coagulation	→	30 to 50	Low power for longer time gives deeper coagulation than high power for short time
Monopolar Desiccation	→	Fine Needle — 10 to 30 Coarse Needle — 20 to 40	See pages 11 and 12 of instructions
Coagulation With Bi-Terminal Electrodes	→	15 to 30	Avoid excess power to prevent damage to electrode through arcing
Sterilization of Furuncle or Abscess	→	30 to 40	Insert fine needle into necrotic center and apply short "flash" of current
Coagulation of Hemorrhoids	→	35 to 45	Use clamp, coagulate stump thoroughly. See Brenner and Warshaw reprints accompanying instructions

while dangerous in the absence of proper precautions, can be used with reasonable safety by the "closed method" if the patient's head and the anaesthetist are seperated from the operating field by moist drapes, if the operating room is continuously ventilated, and care is taken to prevent spillage and to immediately remove empty ether cans.

It should be recognized, of course, that all commonly used inhalant anaesthetics are inflammable and especially so when used with oxygen. Therefore, caution is advised even when such "comparatively safe" gases as nitrous oxide and chloroform are used.

No inhalant of even the slightest degree of inflammability should be used when there is any communication between the operating field and the respiratory passages.

With present day techniques for administering spinal, intro-muscular, oral and and rectal anaesthetics, together with the safer gases, the surgeon has a wide choice from which to select an appropriate anaesthesia for any electrosurgical prodedure.

CHAPTER I

ELECTRO MEDICAL EQUIPMENT

SECTION 3

SHORT WAVE DIATHERMY

Short wave diathermy is the application of high frequency currents and fields for the production of heat in living tissues; the frequency of the current and fields employed is of the order of 10 to 50 million cycles per second, corresponding respectively to wave lengths of 30 to 6 meters.

High frequency currents and fields are generated. By means of vacuum tube oscillators similar to the high frequency oscillators used for the generation of radio waves.

There are in general two methods of application.

(1) By means of the high frequency electric field as exists between plate electrodes.

(2) By means of the high frequency magnetic field generated by the flow of current in a coil which is wound around or round into a pancake type coil and placed over or under the tissues in which it is desired to generate heat.

Since the frequency of the currents flowing in the tissues of the patient are far above those frequencies which elicit neuromuscular response, there is no effect except the generation of heat and those physiological effects which normally follow the generation of heat in tissue.

Claims have been made from time to time that high frequency fields may have a specific bactericidal effect; however, careful investigators both here and abroad have been unable to demonstrate any effect of these high frequency currents except the generation of heat and the production of those physiological effects which normally follow the production of heat in tissue.

In view of the fact that the only effect of high frequency current is the production of heat, that method of application is to be preferred which produces the heat in those tissues in the body where heat is normally produced through energy metabolism, namely, the vascular tissues.

It is definitely undesirable to generate heat in the fat and other non-conductive tissues of the body for such tissues and structures were not meant to have heat generated in them. Under normal conditions these tissues are heated by conduction from the vascular tissues in which heat is produced through energy metabolism.

With the induction field the rate of heat production in conductive tissues such as vascular tissue will be greater than the rate of heat production in non-conductive or adipose or fatty tissues for the same intensity of field.

With the production of heat in the vascular tissues vasodilatation occurs with a resultant active hyperemia.

Nature combats infection, relieves congestion, carries away waste products, and brings about the repair of injured tissues through the agency of the blood stream and of the blood stream alone.

Indications include all inflammatory processes whether of traumatic or infectious origin, such as non-unions, industrial and athletic injuries of all types, infectious processes such as carbuncles, pneumonia, etc.

The minimum intensity required to induce and maintain an active hyperemia should be employed. The physician and technician can judge what this intensity should be by observing whether or not at the end of a 15 minute application perspiration appears on the skin surface of the part undergoing treatment.

In view of the fact that the effect of an active hyperemia is to be achieved, it is desirable to administer long treatments or, if not long treatments, frequent treatments so that the active hyperemia may be maintained as long as possible.

Application should not be made directly and exclusively to the injured part. It is better to distribute the input of electrical energy so that tissues adjacent to the injured tissues may be warmed; for example, if a knee is to be treated, it is preferable to treat the entire leg, thereby bringing about the desired active hyperemia with a minimum input per unit tissue volume of the injured knee itself.

The part under treatment should be insulated against heat loss. By placing a terry cloth towel over the bare skin to absorb perspiration and to prevent pooling of perspiration, covering the turkish towel with light rubber sheeting and then the sheeting with a woolen blanket with electrode applicator placed over the blanket, loss of heat evaporation of perspiration will be prevented. By following this procedure the active hyperemia induced by the treatment may be maintained for a considerable period after the machine has been turned off. In many conditions it has been found desirable to administer a treatment of 15 minutes every hour for 24 hours per day. By keeping the part insulated as described above, the effect of a continuous active hyperemia may be achieved.

The maximum available power output of a short wave diathermy apparatus is usually given as the output of the machine. This maximum available output, as measured by means of a load whose impedance is matched to the impedance of the oscillator, gives no indication of the ability of that machine to introduce power into a patient. It is better that the output of a diathermy machine be expressed in terms of the maximum power that that machine can introduce into a patient. Tests have been conducted on various machines which slow that the useful power output, which is the power that can be introduced into an electrolytic phantom representing probably the maximum patient load ever put on the machine, namely the thoracic region, may be as low as 13% of the maximum available output. A properly designed short wave diathermy machine should be capable of introducing a much higher percentage of the maximum available output into the chest of the average adult patient.

It was found by actual measurement of the temperatures obtained in the deep muscles of the thigh that a power input into the thigh of the order of 75 to 90 watts would result in a final deep tissue temperature of 105 to 107 degrees at the end of 20 minutes. This power input is, in fact more than is usually required. Highly successful technics requiring an input of the order of 50 watts for local treatment are in use today. This procedure is based on the belief that the beneficial effects of short wave diathermy is due to the active hyperemia that is induced and maintained. Obviously a power input greater than that necessary to induce and maintain the desired active hyperemia is not only unnecessary but may give rise to injury to the treated tissues.

SERVICE MANUAL - SHORT WAVE SWDX-80

DESIGN PRINCIPLES AND DESCRIPTION OF CIRCUIT

All diathermies manufactured previous to the Burdick Model SWDX-80 Crystal

Controlled Diathermy consist essentially of self-excited oscillators with the plate tank as the frequency controlling element. The reflected reactance of the patient circuit changes the plate tank reactance, and therefore changes the frequency, over a rather large range due to the large variation in patient reactances necessary to cover all the various patient applications. Since it is possible for energy to radiate from the external patient circuit, there is a probability of interference to short wave radio communication. One individual self excited oscillator type diathermy can cover a great many communication channels, and since there never has been any standard diathermy frequency, the sum total of diathermies of all types and makes produces a probability of radio interference extending over the short wave spectrum from 60 to 10 megacycles.

The Burdick Model SWDX-80 Crystal Controlled Diathermy was developed for the purpose of giving satisfactory diathermy treatments to a patient without causing interference to radio communication. It operates at a specified frequency and tolerance and on a channel selected by the Federal Communication Commission. The Model SWDX-80 operates on the frequency of 13,660 megacycles with a frequency deviation not exceeding ± 0.05%. The elimination of interference to radio communication is accomplished by the supposition that no radio installations will be allocated the 13,660 MC channel, and therefore will not be intefered with by the Model SWDX-80 diathermy, although its external patient circuit may be radiating a signal at 13,660 M.C.

In the Model SWDX-80, the patient circuit is coupled to a Class C amplifier whose grid circuit is energized or "driven" by a piezo-electric quartz crystal controlled oscillator through suitable intermediate amplifier stages, in much the same manner as in conventional radio transmitters. However, the design of the Model SWDX-80 departs from conventional radio transmitter design, to meet the problems that are peculiar to diathermy equipment but are not present in radio transmitters. In a radio transmitter the final amplifier feed energy into a load having a constant resistance and with all reactance substantially tuned out.

In contrast, the final amplifier of the Model SWDX-80 feeds energy into a load whose resistance as well as reactance varies over a very wide range and this reactance may or may not be tuned out of the circuit. Of course, in a conventional transmitter final amplifier, the reflected reactance in the tank circuit will not change the frequency as it does in the conventional self excited oscillator type diathermy, but it would, as is well known in transmitter practice, cause increased plate input at a low plate efficiency and thus overload the tubes.

As will be seen from the wiring diagram, the final amplifier is driven by an exciter consisting of a 6L6 harmonic oscillator with a half-frequency crystal, and with a GL-814 amplifier. The plate and screen voltages of the 6L6 and the DC grid bias voltage for the GL-814 is filtered DC furnished by the "Exciter Power Supply" unit consisting of a 5Y3-GT rectifier and transformer T3. With the crystal pulled out, resulting in no RF grid excitation, the screen and plate dissipation does not exceed rated limits due to the bias from the cathode resistor R2 and also to the relatively low screen and plate voltages used. For normal operation the bias on the GL-814 is about 90 volts, and with the 6L6 tube pulled out is about 47 volts. (See Table I). This bias is sufficient to hold the plate and screen dissipation within rated limits when there is no RF grid excitation. The plate and screen voltages of the GL-814 is pulsating DC tapped off the voltage divider on the "High Voltage Supply" unit consisting of the two 866-A rectifiers and transformer T1. The final amplifier, which is also supplied with pulsating DC plate voltage, has a pair or

FP-265 high mu tubes in push-pull. There is no fixed DC grid bias, being biased only by the grid leak R3, but the high mu characteristic provides sufficient plate current cut off under zero bias to limit plate dissipation within the rated limit when there is no RF grid excitation.

Part of the plate tank capacitance of the final amplifier consists of the "Trimmer" condenser C7 with which the plate tank is tuned to resonance. C7, which is accessible from outside of the cabinet by removing cover plate 18 (Fig. 3), is adjusted and locked with the coupling coil L7 set for zero coupling (POWER CONTROL Fig. 6 set on zero) and with nothing plugged in the CABLE OUTLETS (marked RF OUTPUT on wiring diagram). This procedure differs from radio transmitter practice, wherein the final amplifier is tuned to resonance under full load conditions. It is very important that the final amplifier of the SWDX-80 be tuned to resonance not only with open output circuit and with coupling coil L7 set for zero coupling, but also that this be done with both doors fastened in place on the cabinet and after the unit has been idling for 10 minutes to reach maximum operating

The plate current of the final amplifier is indicated by the DC milliammeter 30 (Fig. 6) and is of course set for minimum reading under the "Trimmer" procedure above. If the final amplifier has been properly "trimmed", and after it has operated a few minutes to reach normal temperature, the plate current will be substantially proportional to the power output of the final amplifier, providing of course that the capacitors C8 and C9 (RESONANCE CONTROL Fig. 6) are adjusted to tune out the reactance in the patient circuit (tuned for maximum plate current). Under these conditions the milliammeter can be used as an output meter, allowing the operator to judge relative dosage.

The overload relay is of the interlock type, which switches off the plate voltage if the plate current exceeds 350 MA, adjusted by R10. It stays locked "off" until the POWER CONTROL is turned down below zero on the dial, thus closing a contact operated by a cam on the L7 shaft and energizing the reset magnet in the relay. Therefore, before plate voltage can be restored, the overcoupled condition that caused the overload is automatically relieved. Since a plate current of 350 MA can be exceeded, even with POWER CONTROL on zero, if the "Trimmer" C7 is set too far off of resonance, the reset mechanism is made to operate against spring tension when closing the reset switch, thereby opening the reset switch as soon as the operator removes his hand from the POWER CONTROL knob. This prevents intermittent on and off action of the overload relay ("door-belling") in the above situation where the excessive plate current was not caused by over-coupling.

Unlike the usual practice in commercial radio transmitter design, the --B of the plate voltage supply is not grounded to the chassis and cabinet in the Model SWDX-80, in order to reduce the haxard of electrical shock. There is less danger of accidental contact with the high voltage DC circuits by a person working on the equipment with the doors off the cabinet, either in the factory or in the field, if the --B is insulated from the steel chassis and cabinet. However, it is necessary to have the --B at ground RF potential, so the --B and RF "ground" points in the circuit are connected to chassis by capacitors C15 on the exciter unit, and C16, C18, and C26 on the final amplifier unit.

A time delay relay is connected in the primary circuit of the two plate transformers and functions to automatically allow a period of approximately 15 seconds of operation of all tube filaments before plate voltage can be applied by OSCILLATOR SWITCH 25 (Fig. 6). This protects the 866-A rectifier tubes and also assures prompt starting of oscillation in the 6L6 circuit.

The cathode heaters and filaments of all tubes are energized by transformer T2, having 5 secondaries. This transformer is a combination filament transformer and line voltage compensating autotransformer. The primary has 12 taps at 2.5 volt intervals and the plate transformer primaries are connected to the 115 volt tap in series with the time delay relay, overload relay and the OSCILLATOR SWITCH on the control panel. The 12 taps connect to a 12 point voltage adjusting switch on the control panel. This permits correct filament, screen and plate voltage within $\pm$2.5% from any line voltage between 100 and 130 volts. The voltage is measured by an AC voltmeter on the control panel, connected across the filaments of the final amplifier tubes. The voltage adjuster 27 (Fig. 6) is set by the operator to bring the VOLTMETER 26 (Fig. 6) reading to the correct point marked on the voltmeter dial.

The primary of the autotransformer T2 is connected to the line receptacle in series with a circuit breaker type of switch on the control panel, MAIN SWITCH 25 (Fig. 6). This provides protection against short circuits and overload, and takes the place of fuses in the line. A radio frequency filter RFC-3A, RFC-3B, C24, C25, is placed at the entrance of the line supply voltage.

Two pilot lights are mounted on the control panel to aid the operator when he is in a position where the meters cannot be seen. A white pilot lamp 31 (Fig. 6), connected between primary taps on autotransformer, indicates when line power is on and filaments energized. A red pilot Light 32 (Fig. 6) connected to a secondary on the exciter power supply plate transformer, T3, indicates when plate voltage is on, A condition where the red pilot goes out when the OSCILLATOR SWITCH is on, indicates that the overload relay has tripped.

SERVICING

DANGER - HIGH VOLTAGE

Since circuit adjustments must necessarily be made with the doors removed from cabinet, the service man *must be alert to the danger of high voltage.* When connecting or disconnecting test meters, and loosening or tightening shaft locks, be sure to remove line cable from receptacle shown at (6) Fig. 2. When making adjustment with the high voltage on, use only the special bakelite tools shown in Fig. 8 and keep the other hand outside of cabinet. *Don't be careless.*

TOOLS - In addition to the ordinary tools used by a radio serviceman, the special tools and equipment shown in Fig. 8 must be provided.

(A) 1/4 watt 115 volt neon glow lamp (T-4½ bulb) attached to the end of a 5/8" dia. by 18"long bakelite rod.
(B) 1/4" dia. by 2¼" long bakelite rod, with one end filed down to a wedge for a screwdriver, and with a bakelite knob on other end.
(C) 3/8" dia. by 7" long bakelite rod, with one end filed down to a wedge for a screwdriver.
(D) Two 1/4 watt 115 volt neon lamps (T-4½ bulb) with bases removed and attached to bronze clips. (Do not use steel clips).

METERS - For a complete measurement of all circuits, the following meters are required. The DC milliameters and DC voltmeters can be of the type and accuracy generally used in radio servicing, but the AC voltmeters should be of the moving coil or iron vane type and not of the type using a DC movement with copper oxide rectifier. The DC voltmeters should be of the "high ohms per volt" type. The DC milliammeters can be of the usual combination volt-ohm-milliammeter type, but since so many current readings have to be made simultaneously, it is preferable to use individual meters, and the small 2½-or 3½-inch panel type are suitable.

(1) 0-150 scale AC voltmeter (for checking line and auto transformer)
(2) 0-15 scale AC voltmeter (for checking voltmeter on panel)
(3) 0-2500 scale DC voltmeter (25000 ohms per volt)
(4) DC voltmeter (25000 ohms per volt) with following scales:
 (a) 0-50
 (b) 0-250
 (c) 0-500
 (d) 0-1000
(5) 0-5 scale DD milliammeter (for 6L6 screen current)
(6) 0-100 scale DC milliammeter (for 6L6 plate current)
(7) 0-25 scale DC milliammeter (for 814 gird current)
(8) 0-50 scale DC milliammeter (for 814 screen current)
(9) 0-150 scale DC milliammeter (for 814 plate current)
(10) 0-150 scale DC milliammeter (for 265 grid current)

VOLTAGE ADJUSTMENT FOR TESTS - In all the test procedures described below, it is to be understood that for every test made, the Voltage Adjuster (27) Fig. 6 must be set on the point that brings the Voltmeter (26) indication as close as possible to the center of the black area (on the arrow). This is a voltage of 10.25 volts, and is the basis for all adjustments, as well as the current and voltage readings in Table I. It is preferable to connect a good AC voltmeter (0-15 scale, see above) to terminals A-A Fig. 9 on auto-transformer (T2) terminal board, and set to 10.25 volts, especially if there is doubt about the accuracy of the voltmeter on the unit.

If the line voltage is of a value that makes it impossible to adjust the Voltage Adjuster to give *exactly* 10-25 volts, then allowance should be made for this in the comparison of measurements with values shown in Table I.

FIRST TESTS TO MAKE - The first thing to check in case of trouble, and before removing doors of cabinet, is the plate current reading (30) Fig. 6, *with the Power Control and Resonance Control both on zero and with nothing plugged into cable outlets.* If the plate current is between 170 and 190 milliamperes, it indicates the exciter is not operating which could be due to an inoperative crystal, 6L6 tube, or 814 tube. The inoperative circuit can be located by the meters as described under "checking tubes".

If the plate current is zero, with Oscillator Switch on and if it cannot be brought on by turning Power Control down below zero to RESET, then see if the 866-A rectifier tubes have a blue glow. (This can be seen by looking through the front door grille, or if preferred the front door can be removed by taking out the two knurled head screws (1) (Fig. I.). If there is no glow in the 866-A tubes, it indicates no plate voltage which could be caused by an inoperative relay assembly (Fig. 9). To check this, short circuit terminals K and L (Fig. 9) on the relay terminal board. (Remove back door by taking out all the 10 screws (2) (Fig. 2.). Refer to "Relay Adjustment".

If the plate current is substantially more than 190 or less than 170 milliamperes then check the "Trimmer" adjustment. (See (7) Fig. 2 and Fig. 3). This "Trimmer" adjustment consists of tuning the final amplifier plate tank to resonance by means of lever (20) Fig. 3 under no load (Power Control on zero) and after the parts have reached normal operating temperature, which generally requires 10 minutes. *This adjustment must be made with both doors on the cabinet.* Unlike transmitter practice, the final amplifier of the SWDX-80 is tuned to reasonable (by C7 Fig. 9) under no load or idling condition. This adjustment is very important, and should be checked by the operator from day to day.

If it is found that for some reason, possibly due to shipment, that the adjusting lever (20) Fig. 3, has insufficient travel to reach minimum reading on the Plate Current milliammeter, it will then be necessary to change the setting of this lever on the "trimmer" condenser shaft. Loosen the shaft clamp on condenser C7 (Fig. 11), and move lever in the required direction, and then tighten shaft clamp screws. It may take several trials to find the proper setting, which is the position that causes minimum plate current at the center of travel of lever 20, with the two maximum plate currents at the two ends being approximately equal.

NOTE: The plate current should reach a minimum of 90 milliamperes or less. For some FP-265 tubes, the minimum idling plate current may exceed 90 MA somewhat, but this is a characteristic of the particular tubes in use and should not be considered abnormal operation. The principal thing to observe in the "Trimmer" adjustment is to adjust C7 for *minimum* idling plate current when the unit has operated for 10 minutes or longer.

CHECK FOR NEUTRALIZATION - If the above "Trimmer" adjustment does not restore operation to normal, a check for neutralization of the final amplifier should be made. Remove the crystal from its socket, and turn on the Oscillator Switch. If the final amplifier is neutralized and if it is not self-oscillating from some other cause, the plate current will indicate between 170 and 190 milliamperes (static operation) and the neon lamp on the bakelite rod Tool A (Fig. 8) will not light up when the base contact is touched on the plate caps of the FP-265's or on any part of the tank coil and neutralizing condensers. A check for oscillation of the exciter amplifier should be made by applying Tool A (Fig. 8) to the plate cap of the 814.

If no RF is indicated on the above tests, and the operation was abnormal under "Trimmer" adjustment above, then the tubes should be checked. If RF is indicated by the neon lamp on the above tests, then the final amplifier should be neutralized, as described under "Neutralizing Final Amplifier".

CHECKING TUBES - The proper location of all tubes, plate clips, and crystal is shown in Fig. 4 and Fig. 5, and this should be checked for proper installation.

A tube with burned out filament (except the 6L6) can be found easily by inspection, with MAIN SWITCH on and OSCILLATOR SWITCH off. "Air leakers" can be detected by the white deposit on the inside of the glass bulb. A defective 866-A rectifier tube will have the inside of the glass bulb covered with mercury films, which could be caused by improper conditioning when installed, that is by not operating for 5 minutes with plate voltage off.

Of course, defective tubes can be eliminated by replacing with spare tubes until operation is restored to normal, but the best way to check the tubes, as well as to check the circuit adjustments, is to measure the DC currents and voltages in the tube circuits. Abnormal readings (Refer to Table I) will indicate either defective tubes or improper circuit adjustments. (It will also indicate defective components, for example, a very high milliammeter reading in the G1-814 plate current position would indicate a shorted capacitor C17). In general a defective tube, if the filament is not burned out, will have either a low plate current if emission is low or a blue have and high plate current if gas is present. (The latter of course does not apply to the 866-A mercury rectifiers). Excessive plate current may also be due to improper circuit adjustment, most often due to off-resonant tuning of the plate tank. Excessive plate current can also be due to improper neutralization, excessive plate voltage, insufficient grid bias, or excessive RF grid excitation. If grid and plate voltages are correct, below-normal plate current is usually a sign of subnormal emission.

Connect the following meters in the circuit. The milliammeters are connected in series by first disconnecting the wires at the terminals indicated in Fig. 9 and Fig. 10, according to the detail instructions below. The position of these terminals are also shown by the corresponding letters on the wiring diagram. Each wire in the unit is identified by a number attached to the wire about an inch from the end. (Refer also to drawing of Terminal Board connections).

6L6 I_s Screen grid current--connect the 0-5 scale DC milliammeter in series with wire #27 and terminal SC on exciter power supply terminal board. (Fig. 10)

6L6 I_p Plate current--connect the 0-100 scale SC milliammeter in series with wire #28 and terminal PL on exciter power supply terminal board. (Fig. 10)

814 I_g DC grid current--connect the 0-25 scale DC milliammeter in series with wire #29 and terminal -C on exciter power supply terminal board. (Fig. 10)

814 I_s Screen grid current--connect the 0-50 scale DC milliammeter in series with wire #30 and junction of R8 and R9 shown at Q. (Fig. 9)

814 I_p Plate current--connect the 0-150 scale DC milliammeter in series with wire #63 and terminal on RFC-1 shown at W. (Fig. 10)

FP-265's I_g DC grid current--connect the 0-150 scale DC milliammeter in series with the orange colored wire #85 and terminal on grid leak resistor R3 shown at P. (Fig. 9)

FP-265's I_p Plate current--read on the milliammeter on Control Panel.

6L6 E_s Screen grid voltage--connect the 0-250 scale DC voltmeter (25000 ohms per volt) with the negative lead to -B terminal and positive lead to SC terminal, both on exciter power supply terminal board. (Fig. 10)

6L6 E_p Plate voltage--connect the 0-500 scale DC voltmeter (25000 ohms per volt) with the negative lead to -B terminal and positive lead to PL terminal, both on exciter power supply terminal board. (Fig. 10)

814 E_g Grid bias voltage--connect a DC voltmeter (25000 ohms per volt) with the negative lead to the -C terminal and positive lead to the -B terminal, both on exciter power supply terminal board. (Fig. 10). When measuring the conditions under 1 and 2 in Table I, use the 0-250 scale. When measuring the conditions under 3 and 4 use the 0-50 scale.

814 E_s Screen voltage--connect a DC voltmeter (25000 ohms per volt) with the negative lead to the top end of R9 (wire #44, #55 and #60) shown at S in Fig. 9. Connect the positive lead to the junction of R8 and R9 (wire #30) shown at Q in Fig. 9. When measuring the conditions under 1 in Table I, use the 0-250 scale. When measuring the conditions under 2, 3 and 4 in Table I, use the 0-1000 scale.

814 E_p Plate voltage--connect the 0-2500 scale DC voltmeter (25000 ohms per volt) with the negative lead to the top end of R9 (wires #44, #55 and #60) shown at S in Fig. 9. Connect the positive lead to the junction of R7B and R8 (wire #63) shown at U in Fig. 9.

FP-265's E_p Plate voltage--connect the 0-2500 scale DC voltmeter (25000 ohms per volt) with the negative lead to the top end of R9 (wires #44, #45 and #60) shown at S in Fig. 9. Connect the positive lead to the top end of R7A (wire #61) shown at V in Fig. 9.

Table I, gives typical values of the current and voltages for a normally operating unit. Except for the grid currents, 814 I_g and FP-265's I_g which are set "exact" by adjustment, the values in Table I can be given a tolerance shown on the lines "maximum" and "minimum". Table I gives values, in Columns 1, 2, 3 and 4, for four different conditions of operation, shown in the first column.

To check the FP-265 tubes, use conditions 1 and 2.
To check the 814 tube use conditions 1, 2, and 3.
To check the 6L6 tube use condition 1 and 2.

To check the 5Y3-GT and 866-A tubes, use only condition 4; that is, with the 6L6, 814 and FP-265's out of sockets, and then measure voltage only.

In using the above method and Table I as a "tube checker" it, of course, assumes all adjustments are correct. If the values in Table I are checked within the limits shown, it not only indicates the tubes are "O.K." but also that the adjustments are "O.K." If the measured values cannot be checked with those in Table I, then the exciter adjustments and neutralization procedure shown below must be carried out before it can be determined whether or not the tubes are "O.K."

TUBE SUBSTITUTIONS - It is preferable to get replacement tubes from The Burdick Corporation because they will have been tested in the SWDX-80 circuit before shipping, but in an emergency replacement tubes can be gotten elsewhere and even substitutes used. However, there is no substitute for the General Electric FP-265 high mu tube.

Any reliable make of the types 814, 6L6 (metal), 5Y3-GT and 866-A can be substituted for the brands shipped with the unit, but they must be of the same type. (Example, RCA-814 for General Electric GL-814)

Do not substitute a glass 6L6 (6L6-G) for the metal 6L6, because it causes excessive crystal RF current. In an emergency type 6V6-G can, in most cases, be substituted for the 6L6, but the 814 DC grid current should be checked and C2 adjusted to give at least 5 MA (but not over 8 MA).

EXCITER ADJUSTMENTS - Connect all meters in the circuit as described above under "Checking Tubes". Disconnect wire #62 (Fig. 10) leading from RFC-2 (Fig. 10) on final amplifier from the terminal on the 866-A socket mounting panel, and lay the wire in a position so the bare end will not come in contact with anything. Loosen the shaft lock nut on each of the condensers C4 (Fig. 10) and C5 (Fig. 11).

With the Tool B (Fig. 8) adjust C2 (Fig. 10) to give exactly 8 MA of DC grid current on the 814 tube after final temperature conditions have been reached. C2 *must be set on the "low capacity side of resonance"*. The shaft of condenser C2 has been painted red on one side, and this red mark appears at the front side when the rotor plates are completely *in* (maximum capacity). Then by starting with the red mark at the front, slowly turn the shaft (either direction) and do not stop when 8 MA is reached the first time, but continue to turn the shaft in the same direction through the resonance peak ($I_g = 15$ or over) and then decrease until again 8 MA is reached which is the correct setting on the "low capacity side of

resonance". Whenever adjustments of C2 are made and there is doubt as to which side of resonance the condenser is set on, always check by starting all over again with red mark at front and repeat the above procedure.

If it is impossible to get any DC grid current to the 814 grid, it indicates no oscillation which could be due to an inoperative 6L6 tube or crystal. If grid current on the 814 is present when crystal is removed, it indicates the 6L6 is self-oscillating, probably due to an improper setting of C2.

Next, tune C4 (Fig. 10) to resonance by means of Tool C (Fig. 8) through the hole in shield. Tune C4 for *minimum plate current* and *maximum screen current* on the 814 tube.

Next, tune the final amplifier grid tank condenser C5 (Fig. 9) using Tool C (Fig. 8), to give 80 MA of grid current to the FP-265's. (This will be set to 75 MA later, when plate voltage is applied to the FP-265's.) This setting must be made to give 80 MA of DC grid current, on the *"low capacity side of resonance"*. Start with rotor plates completely *out* and stop at the first point 80 MA is reached. (The DC grid current will be about 90 MA at resonance.)

If it is impossible to get any DC grid current to the FP-265's, it indicates no RF in the plate circuit of the 814, due either to an inoperative 814 tube (or circuit) or to no grid excitation on the 814. Grid excitation on the 814 is indicated by the DC grid current (on the 814).

NOTE: While the adjustments of C2, C4 and C5 are described above as individual steps, all three adjustments should be simultaneous. Since it is impossible to make all three adjustments simultaneously, make them in the order given above, and then go from one to the other, "touching" them up, until the final result is as follows, after final temperature conditions have been reached:

C2 set on "low capacity side of resonance" to give 814 I_g = 8 MA
C4 set on resonance to give 814 I_p minimum (and 814 I_{sc} maximum)
C5 set on "low capacity side of resonance" to give FP-265's I_g = 80 MA

NEUTRALIZING FINAL AMPLIFIER - First connect all the meters in the circuit as described above under "checking tubes". Disconnect the plate voltage on FP-265's by removing wire #62 (Fig. 10) from 866-A filament terminal, and make the adjustments on C2, C4 and C5 described above under "Exciter Adjustments".

Clip the ¼ watt neon lamps D (Fig. 8) one on each plate clip of the FP-265's as shown in Fig. 9. Loosen lock screw 19 (Fig. 9) on trimmer condenser C7 (Fig. 9). Loosen lock nuts on each neutralizer condenser C_n (Fig. 9 and Fig. 11).

The principle involved in neutralizing the final amplifier, is to so adjust the capacity of the two neutralizing condensers C_n to allow an amount of RF current to flow through them equan in quantity but in opposite phase to the current flowing through the grid to plate capacitance of the tubes. This has to be done, so the FP-265 stage will act only as an amplifier, and not as a self oscillator, as it would do if not neutralized, because of current from the plate circuit being fed back to the grid circuit through the grid to plate capacitance in the tubes. When plate voltage is removed, and RF grid voltage is applied to the grids (indicated by the DC grid current), RF current will flow in the plate tank (when tuned to resonance) if the amplifier is not neutralized. That is why the ¼ watt neon lamps are clipped to the tube plates,—to indicate the presence of RF. The neutralizer condensers are adjusted, and at the same time the tank capacity is "trimmed" for

resonance, until the neon lamps go out, indicating no feed through from grid to plate circuits of the RF on the grid tank which indicates the amplifier is neutralized.

The step by step neutralizing procedure is as follows: With plate voltage off and grid excitation on (I_g = 80 MA), move adjusting lever 20 (Fig. 9) up or down until the neon lamps glow at maximum. If the limit of travel of the lever 20 prevents reaching the resonance point, or if the neon lamps will not even light up (assuming, of course, that the amplifier is not already neutralized) it will be necessary to loosen the shaft clamp on condenser C7 (Fig. 11) and make the adjustment with Tool C (Fig. 8) applied to the shaft of C7. If this is done, first set adjusting lever 20 so top edge is even with lock screw 19 and then tighten lock screw so that after final adjustments are made, and the shaft clamp tightened, the adjusting lever 20 will be set in the proper position.

With C7 set to resonance as indicated by maximum glow in neon lamp, make the neon lamp go out by adjusting each of the neutralizing condensers C_n with Tool C, (Fig. 8) keeping the adjustment of each one the same as much as possible. (Two neon lamps are used so as not to unbalance the circuit by the capacity to ground, and it may be found that the two lamps will not go out simultaneously - if not-then go by the one that goes out last.) After the lamps are put out by one neutralizer Cn, retune C7 which should light them again and then made them go out by adjustment of the other neutralizer C_n. When the stage is badly out of neutralization, these first attempts will probably not put the neon lamps out completely, so adjust Cn for minimum glow. *Remember to always return C7 to resonance after any change in either one of the neutralizers C_n and also "touch" up C4, keeping the 814 plate tank in resonance.*

When neutralization has been closely approched, it will be found that each neutralizer shaft can be turned quite a bit with the neon lamps off. The procedure now is to find the exact setting of each neutralizer in this "neon lamp out condition". Turn the Cn shaft in one direction just far enough to bring neon lamp on. (The neon lamps can be made to light up quicker by touching the bulb with finger.) With neon lamp on, make a careful resonance peak adjustment with C7. Now turn shaft *back* and make a mental note of the shaft position *when neon lamp goes out, then* repeat all of this by moving the shaft in the opposite direction. Set the shaft in the position midway between the two positions where the neon lamp w*ent out.* This whole process must be repeated with the other neutralizer condenser, and possibly several times, going from one neutralizer condenser to the other.

Remember to always keep C7 (and C4) tuned to resonance for every change in C_n.

When the amplifier has been neutralized, remove the two neon lamps but do not lock any adjustments yet. Connect plate voltage to the final amplifier, by replacing wire #62 back on the 866-A filament terminal. With plate voltage,on, tune the final amplifier tank to resonance with C7 (as indicated by minimum plate current milliammeter on panel).

Check all the following final adjustments after unit has been operating about 10 minutes to be sure final temperature has been reached:

C2 set on "Low capacity side of resonance" to give 814 I_g = 8 MA
C4 set on resonance to give 814 Ip minimum (and 814 I_{sc} maximum)
C5 is not set to give I_g = 75 MA to FP-265 grids, on low capacity side of resonance "

After these adjustments are made. remove the crystal and turn on the Oscillator Switch. If the final amplifier is neutralized, the FP-265 DC grid current will be

zero and plate current somewhere between 170 and 190 milliamperes. The neon lamp on Tool A (Fig. 8) will not light up when the base contact is touched on the plate caps of the FP-265's or on any part of the tank coil and neutralizing condensers, and it should not light up when contacted on the plate cap or the 814. If the FP-265's show grid current, and the neon lamp lights up, it will be necessary to repeat the neutralizing process.

Sometimes, it is necessary to slightly detune the 814 plate tank condenser C4 by *increasing* the capacity to make the neon lamps go out on the above test, but this should not be resorted to unless absolutely necessary, and should not be detuned enough to lower the FP-265 grid current more than a few MA.

After the tests show the final amplifier is neutralized, lock the adjustments on C4, C5, C7 and C_n by tightening the shaft lock nuts. To make sure adjustments were not disturbed while locking, make a final check on the current readings and also for neutralization. Check current and voltage measurements with Table I.

NOTE: If all tubes and circuits are known to be O.K., the neutralizing Procedure, as well as adjustments on the exciter can be done with only two milliammeters as follows:

1. A 0-25 scale, to read DC grid current on the 814, Set C2 on the "*Low Capacity side of resonance*" to give exactly 8MA at all times.
2. A 0-150 scale, to read DC grid current on the FP-265's. Set C5 on the "low capacity side or resonance" to give 80 MA when plate voltage is removed from the FP-265's and 75 MA when plate voltage is on. Always keep C4 tuned to resonance, indicated by maximum reading.

RELAY ADJUSTMENT - The interlock Overload Relay and the Time Delay Relay are located within the dust cover shown in Fig. Q. All adjustments on these devices are made at the factory by special test equipment, and if any trouble occurs, that cannot be corrected by adjusting R10 explained below, it is best to remove the whole relay assembly unit and return it to the factory. The unit is removed by disconnecting the wires from the terminal board, and removing one screw at top and two at the bottom. Remove the two mounting screws on the final amplifier chassis on the side directly over the relays and lift that side of the final amplifier assembly far enough to allow the relay chassis to be removed.

The adjustable resistor R10 (Fig. 9) should be set so the overload relay will trip when the final amplifier plate current exceeds 350 MA. Any value in the RED area of meter scale is O.K., (not below 350 MA and not over 400 MA). Move the adjustable clamp upward to make the relay trip at a higher value of plate current, and downward for a lower value.

For making the adjustment, the Treatment Drum can be loaded with a phantom load consisting of two 32 volt 100 watt Mazda lamps in parallel connected to a two turn 8" diameter loop of #14 insulated wire. Place the loop directly on the face of the Treatment Drum.

The time delay relay has been adjusted at the factory for a delay of from 15 to 20 seconds. The actual time delay depends on room temperature, taking a longer time for low temperature and a shorter time for a high room temperature. The actual value of the time delay of course is not critical, so it is not important for it to be exactly 15 seconds.

CHECKING POWER SUPPLIES - The voltage divider resistors in both power supply units can be tested for ohms and open circuits in the usual manner, with an Ohmmeter. The DC power supply voltages can be checked by removing the 6L6, 814, and FP-265 tubes and comparing voltage measurements with those in column 4 Table I. This of course assumes that the rectifier tubes are O.K. The transformer voltages can be checked by removing rectifier tubes and comparing measured voltages with the voltage shown under "Transformers".

MAINTENANCE

CAUTION: NEVER REMOVE DOORS OF CABINET UNLESS LINE CABLE IS DISCONNECTED FROM RECEPTACLE. See Fig. 2 at (6).

TRIMMER ADJUSTMENT - The "Trimmer" adjustment should be checked quite often to see if the no load plate current is actually in its minimum value.

OILING BLOWER MOTOR - The exhaust blower motor must be oiled every three months with S.A.E. No. 20 motor oil. To oil motor, remove the four screws holding the blower panel to front of cabinet, as shown in Fig. 7A. With one hand, hold the top of front foor and bottom of lower panel, and tilt top of blower panel forward exposing oil holes 22 and 23 in motor, which can be oiled with the other hand as shown in Fig. 7B. (If preferred, the front door can be removed first, and the blower panel slid down to rest on the exciter chassis cover.)

CLEANING - Every three months, or oftener if necessary, the dust should be cleaned off of the parts inside of cabinet. The best way to do this is to remove both front and rear doors and use an electric hand blower. Be careful to not disturb any parts that might be thrown out of adjustment, and to not blow dust up in under dust cover on relay assembly Fig. 9.

COMPONENT PARTS

In the following list of parts used in the Burdick model SWDX-80 Crystal Controlled Diathermy, the manufacturer's name is given for the parts actually used. In many cases parts of identical specifications made by other manufacturers can be used for replacement. However, many of the parts are made special to Burdick Corporation specifications, and others on account of mechanical fit, will permit of no substitution, and those parts in the following list are indicated by (N.S.).

FREQUENCY CONTROL DEVICE

Type MC5 Bliley piezo-electric quartz crystal with holder to fit contacts numbers 2 and 4 of standard 5 contact tube socket. Temperature coefficient not to exceed 4 cycles per megacycle per degree centigrade. Calibrated 6830.0 kilocycles at 25° C.

TUBES

2—General Electric type FP-265 high mu triodes (N.S.).
1—General Electric type GL-814 beam tetrode.
1—RCA type 6L6 metal beam tetrode.
2—RCA type 866-A mercury rectifiers.
1—RCA type 5Y3-GT rectifier.

RESISTORS

R1—100000 ohms ± 10%, 2 watt, insulated carbon type, Speer SI-2.
R2— 400 ohms ± 10%, 2 watt, insulated carbon type, Speer SI-2.
R3— 3000 ohms ± 5%, 100 watt, Ohmite wire wound vitreous enameled.

R4— 5000 ohms ± 5%, 25 watt, Ohmite wire wound vitreous enameled.
R5— 7000 ohms ± 5%, 25 watt, Ohmite wire wound vitreous enameled.
R6— 1500 ohms ± 5%, 100 watt, Ohmite wire wound vitreous enameled.
R7A—3000 ohms ± 5%, 100 watt, Ohmite wire wound vitreous enameled.
R7B—3000 ohms ± 5%, 100 watt, Ohmite wire wound vitreous enameled.
R8—35000 ohms ± 5%, 100 watt, Ohmite wire wound vitreous enameled.
R9—25000 ohms ± 5%, 100 watt, Ohmite wire wound vitreous enameled.
R10— 100 ohms ± 10%, 50 watt, Ohmite "Dividohm" adjustable type wire wound vitreous enameled.

VARIABLE AIR SPACED CAPACITORS

C1—Johnson type 100J12, 102 mmf, air gap .025" rated 1200 volts.
C2—Johnson type 50J12, 55 mmf, air gap. 025" rated 1200 volts.
C4—Johnson type 35H30, 35 mmf, air gap .80", rated 3000 volts (N.S.)
C5—Johnson type 70FD20 dual section, 33 mmf. total, air gap .045" rated 3000 volts (N.S.L
C7—Johnson type 30 ED45, dual section, 15 mmf. total; air gap. ,125", rated 9000 volts. (N.S.)
C8 and C9—Johnson type 100D70, 100 mmf, air gap .185", rated 7000 volts (N.S.)
N_n—Johnson type N250 made to Burdick specifications, 18 mmf. air gap .250", rated 9000 volts. (N.S.)

FIXED AIR SPACED CAPACITORS

C6—Burdick, special, air gap .279", rated 7800 volts, steel frame, mycalex insulation. (N.S.)

MICA CAPACITORS (all low loss bakelite)

C3—Solar type MOSW-50-5, Silver mica, 50 mmf. ± 5%, 500 volts DC operating.
C10, C11, and C12—Solar type XBBW .5-25-10, size A mold, .005 mf ± 10%, 500 volts DC operating.
C13—Solar type XBBW .5-15-10, size B mold, .05 mf. ± 10%, 500 volts DC operating.
C14—Solar type XBBW 1-13-10, size B mold, .03 mf. ± 10%, 1000 volts DC operating.
C15, C16, C17 and C26—Solar type XBBW 2-25-10, size B mold. ,005 mf. ± 10%, 2000 volts DC operating.
C18—Solar type XBBW 3-22-10, size B mold, .002 ± 10%, 3000 volts DC operating.

PAPER CAPACITORS

C19 and C22--Solar type S-0235, wax sealed tubular type, .1 mf. ± 10%, 200 volts DC operating.
C20 and C21--Solar type 2XDMR2-.1, dual mineral oil impregnated and filled, drawn shell container, .1-.1 mf. ± 10%, 200 volts DC operating.
C24 and C25--Solar type S-0240, wax sealed tubular type, .1 mf. ± 10%, 600 volts DC operating.

ELECTROLYTIC CAPACITORS

C23—Solar type CY with DYP-4 insulating mounting plate, round metal container for twist-prong mounting. 3 sections, 8 + 8 + 8 mf, 450 volts DC operating.
C27—Solar type MS-50100, metal tubular with cardboard insulating tube, 100 mf, 50 volts DC operating.

METERS

AC Voltmeter, Triplett type 331, 3½ inch diameter moulded bakelite, full scal 13 volts, blocked out range from 10 to 10.5 volts with calibration at 10.25 volts on the arrow marker.

DC Milliammeter--Triplett type 321, 3½ inch diameter molded bakelite, 400 MA full scale.

TRANSFORMERS (N.S.)

All transformers are designed and manufactured by the Burdick Corporation and there are no substitues.

T1--Plate transformer for high-voltage power supply. Secondary, 1710 volts each side of center-tap with secondary open circuited and 115 volts (50 or 60 cycles) on primary terminals and I and F (Fig. 9). Secondary rated at 0.393 amperes RMS or 0.500 amperes DC. Primary rated at 10 amperes and 1150 volt-amperes. Insulation tested at 11000 volts AC. DC resistance of entire secondary winding is 217 ohms.

T2--Combination filament transformer and voltage adjusting auto transformer. 12 primary taps at approximately 2.5 volt steps.
Line volts: 100-130
Cycles: 50 or 60
Primary volt-ampere rating: 1375

FILAMENT SECONDARY	FILAMENT VOLTAGE FOR	AC VOLTS*	AMPERE RATING	INSULATION TESTED AT
A-A	2FFP-265's	10.70	10.40	1600 volts AC
B-B	GL-814	10.70 CT	3.25	1600 volts AC
C-C	5Y3-GY	5.30	2.00	1600 volts AC
D-D	6L6	6.60	1.05	1600 volts AC
E-E	2 866-A's	2.87	10.00	11000 volts AC

*These are open circuit voltages (all 7 tubes out) and with 115 volts on the 115 volt primary tap, measured at terminals I and G (Fig. 9) on autotransformer terminal board (see Wiring Diagram and drawing of Terminal Boards).

T3--Plate transformer for low voltage power supply. Secondary voltage of 378 volts each side of center tap, with secondary open circuited and with 115 volts (50 or 60 cycles) on primary terminals I and F (Fig. 9). Secondary rated at 0.043 amperes. RMS or 0.055 amperes DC. Primary rated at 0.35 amperes and 40.25 volt-amperes. Pilot light secondary open circuit voltage 6.35 volts and rated at 0.15 amperes. Insulation tested at 1600 volts AC. DC resistance of entire secondary winding is 331 ohms.

IRON CORED CHOKES

CH-1--Thordarson Type T-44C02, 12 henries at 80 MA, 405 ohms, insulation tested at 1600 volts AC.

CH-2--Thordarson Type T-57C51, 6 henries at 80 MA, 138 ohms insulation tested at 1600 volts AC.

RADIO FREQUENCY CHOKES

RFC-1 Ohmite type Z-2 (N.S.)
RFC-2 Ohmite special to Burdick Corporation specifications. (N.S.)
RFC-3A and RFC-3B Ohmite type Z-21

RF REACTORS AND INDUCTANCE COILS

L1 and L2--Brudick (N.S.)

L3--National type R100U, 2.5 milli-henries, distributed capacity 1 mmf, DC resistance 50 ohms, current rating 125 MA, mounted on Stealite stand-off insulator.

L4--Barker & Williamson, Type 20 BL end linked.

L5—Barker & Williamson, Type 20BL center linked and center topped.
L6 and L7—Burdick (N.S.)

RELAYS

Guaradian to Burdick Corporation specifications (N.S.)

MAIN SWITCH CIRCUIT BREAKER

Heineman to Burdick Corporation specifications (N.S.)

VOLTAGE CONTROL SWITCH

Ohmite type 212-12 rated at 15 amperes 150 volts AC.

OSCILLATOR SWITCH

Hart & Hegeman #8700E rated 15 amperes 125 volts.

PILOT LIGHT BULBS

Both lamps have Mazda #40, 6.3 volt bulbs.

PLOWER

Grainger to Burdick Corporation specifications (N.S.)

TUBE SOCKETS

For FP-265's--Westinghous special (N.S.)
For GL-814--Johnson Steatite #225, 5 contact
For 6L6--American Phenolic, Steatite #SS8, octal
For 5Y3-GT--American Phenolic Bakelite #S8, octal
For 866-A's--American Phenolic, Bakelite #MIP4, 4 contacts
For Crystal--American Phenolic, Steatite #SS5, 5 contacts

LINE CABLE

U.S. Rubber Co., 10½ feet long, #14 Type S hard service rubber jacketed 3 conductor cord, specifications 744 S with Belden H-1404 plug.
Other end of cable fitted with Harvey Hubbell #BC-113573 3 wire plug with cord grip.
Line receptacle in cabinet, Harvey Hubbell #7556 3 wire receptacle.

TABLE I

Refer to Page 8

Voltage Adjuster on Panel must be set to give 10.25 volts AC on terminals A-A of transformer T2. (See Page 6) Voltmeter on panel should read on arrow at center of black area.		DC MILLIAMPERES							DC VOLTS					
		6L6		GL-814			FP-265's		6L6		GL-814			FP-265's
		I_s	I_p	I_g	I_s	I_p	I_g	I_p	E_s	E_p	$-E_g$	E_s	E_p	E_p
1 Regular operation with crystal and all tubes in.	TYPICAL	**1.20**	**27.5**	**8**	**17**	**50**	**75**	**80**	**168**	**292**	**92**	**173**	**990**	**1450**
	Maximum	1.60	32.0	See	20.	57	See	95	185	315	100	200	1080	1525
	Minimum	.80	23.0	Note 1	15	43	Note 2	65	150	270	84	155	900	1375
2 Operation with crystal out.	TYPICAL	**1.10**	**28.5**	**0**	**0.7**	**10**	**0**	**177**	**171**	**300**	**83**	**510**	**1260**	**1450**
	Maximum	2.00	33.0	---	2.0	20	----	190	185	325	91	560	1355	1525
	Minimum	.80	24.0	---	.5	8	----	170	155	275	75	460	1165	1375
3 Operation with crystal and 6L6 tube out.	TYPICAL	----	----	**0**	**2.5**	**35**	**0**	**177**	**221**	**375**	**47**	**415**	**1110**	**1440**
	Maximum	----	----	----	5.0	45	----	190	245	400	52	460	1200	1515
	Minimum	----	----	----	2.0	30	----	170	200	345	42	375	1025	1370
4 Operation with crystal, 6L6, GL814, and FP-265 tubes out.	TYPICAL	----	----	----	----	----	----	----	**214**	**362**	**45**	**545**	**1300**	**1440**
	Maximum	----	----	---	----	---	----	----	235	390	49	590	1365	1515
	Minimum	----	----	----	----	----	----	----	195	335	41	500	1235	1370

Note 1. 8 MA is MAXIMUM, set by C2 on "Low Capacity Side of Resonance." Changes with temperature of 6L6 tube, so final setting of C2 must be made after final temperature is reached (about 10 min.).

Note 2. Set to 75 MA by C5 on "Low Capacity Side of Resonance." Is quite critical to adjust to exactly 75 MA, but any value between 72MA and 78MA is OK. Must have its final adjustment after final temperature is reached. (About 10 min.)

BURDICK SWDX-80 SHORT WAVE DIATHERMY

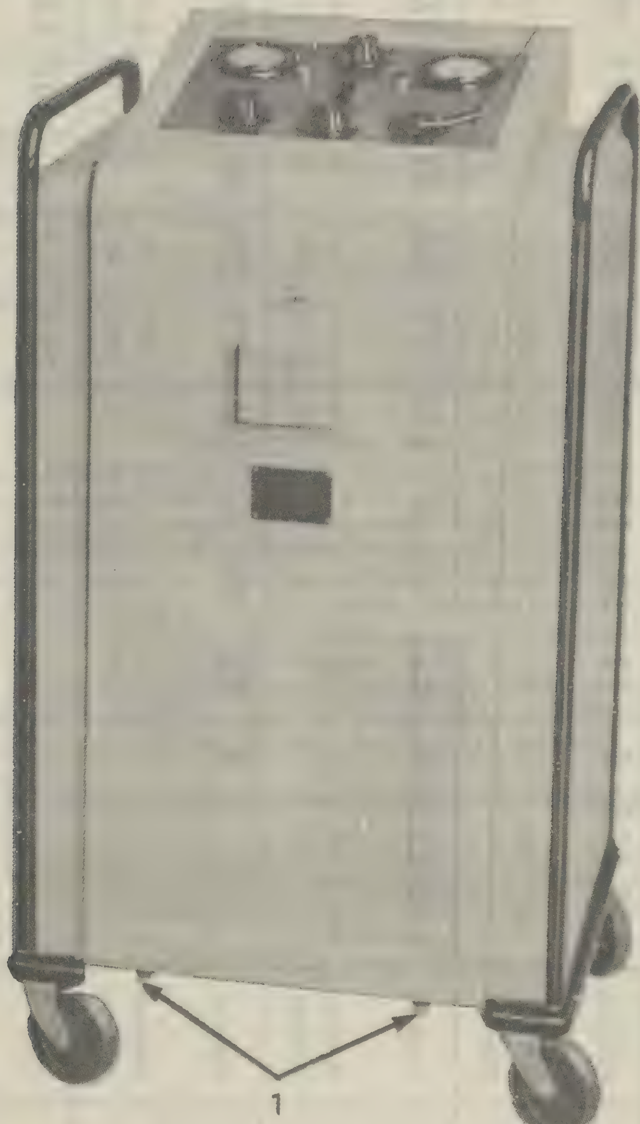


FIGURE 1

(1) Two knurled head screws fastening front door.

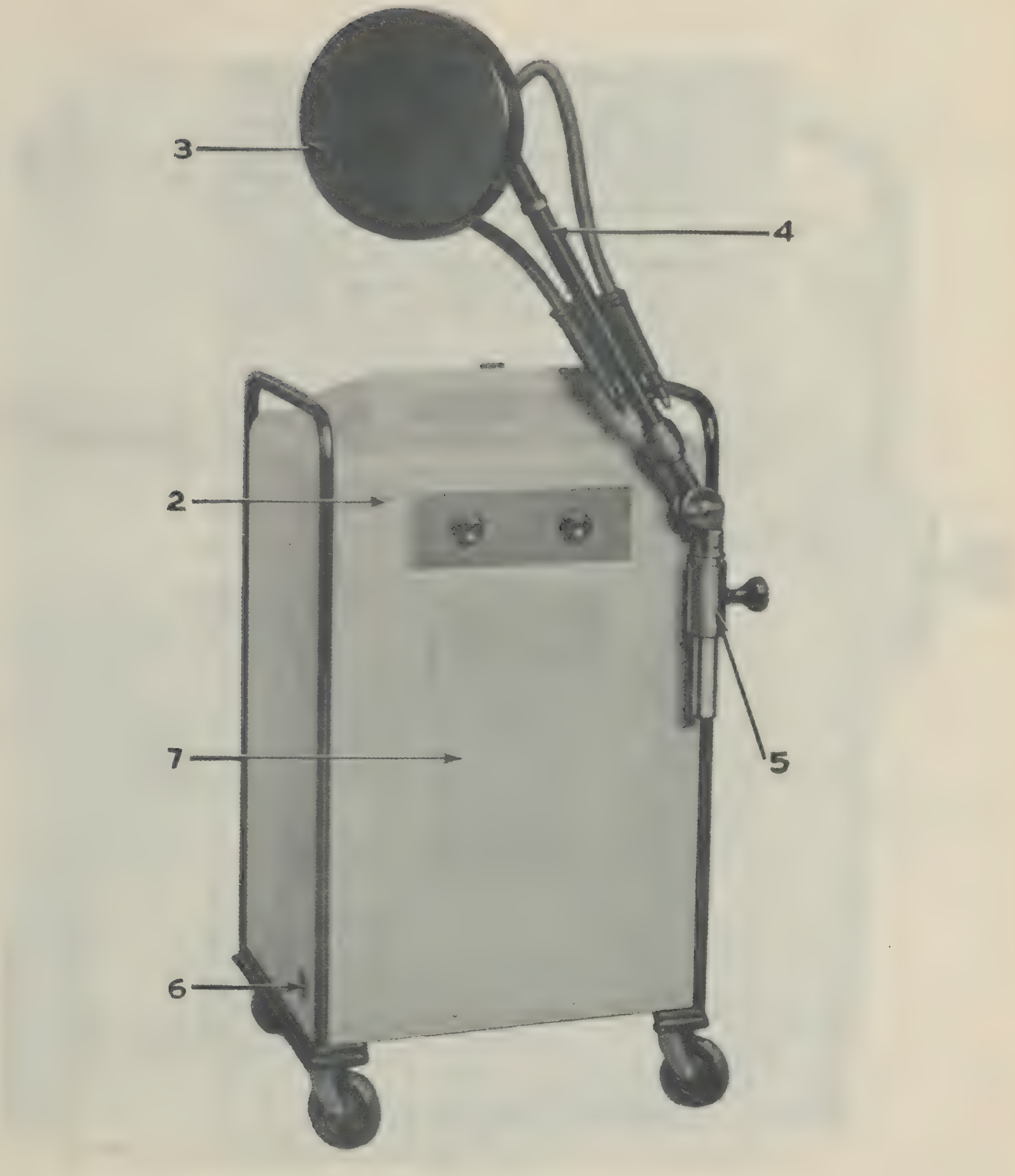


FIGURE 2

(2) 10 screws fastening rear door.
(3) Treatment Drum.
(4) Adjustable arm.
(5) Arm holder.
(6) Line cable receptacle.
(7) Cover plate for "trimmer" condenser.

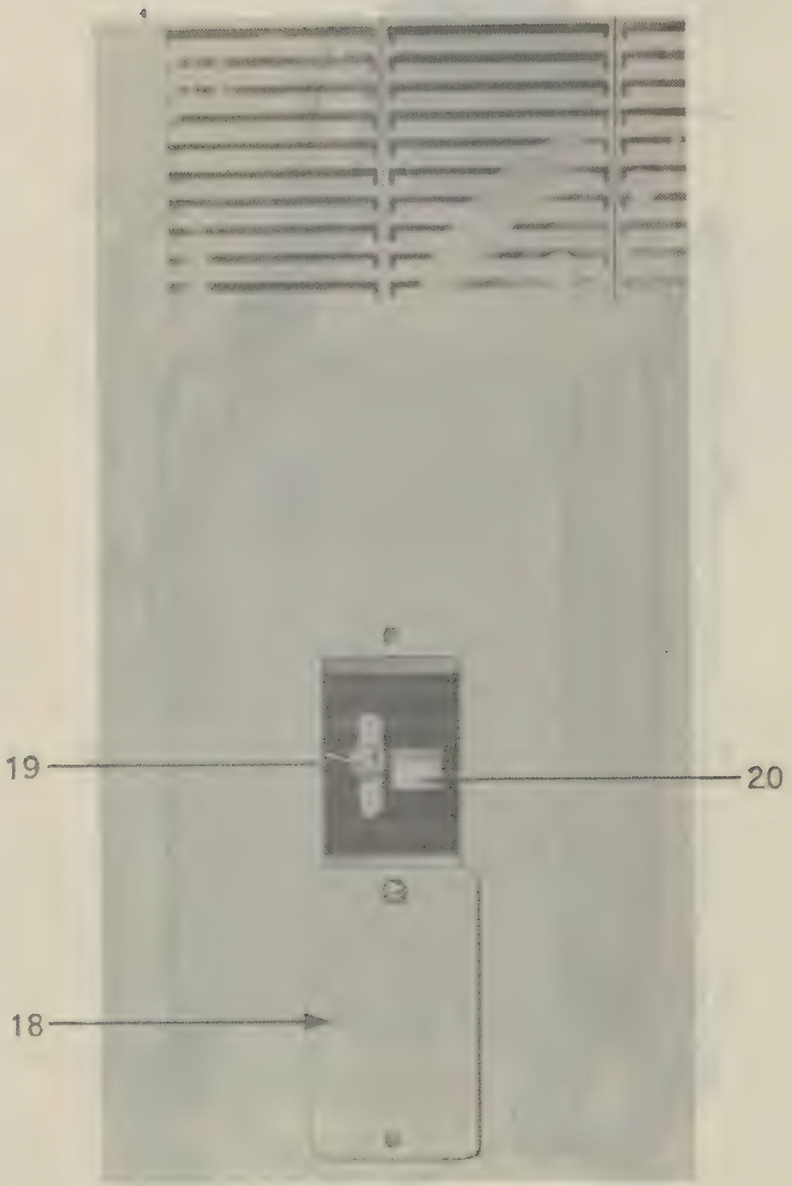


FIGURE 3

(18) Cover plate for "trimmer" condenser.
(19) Lock screw for "trimmer" condenser.
(20) Adjusting lever for "trimmer" condenser.

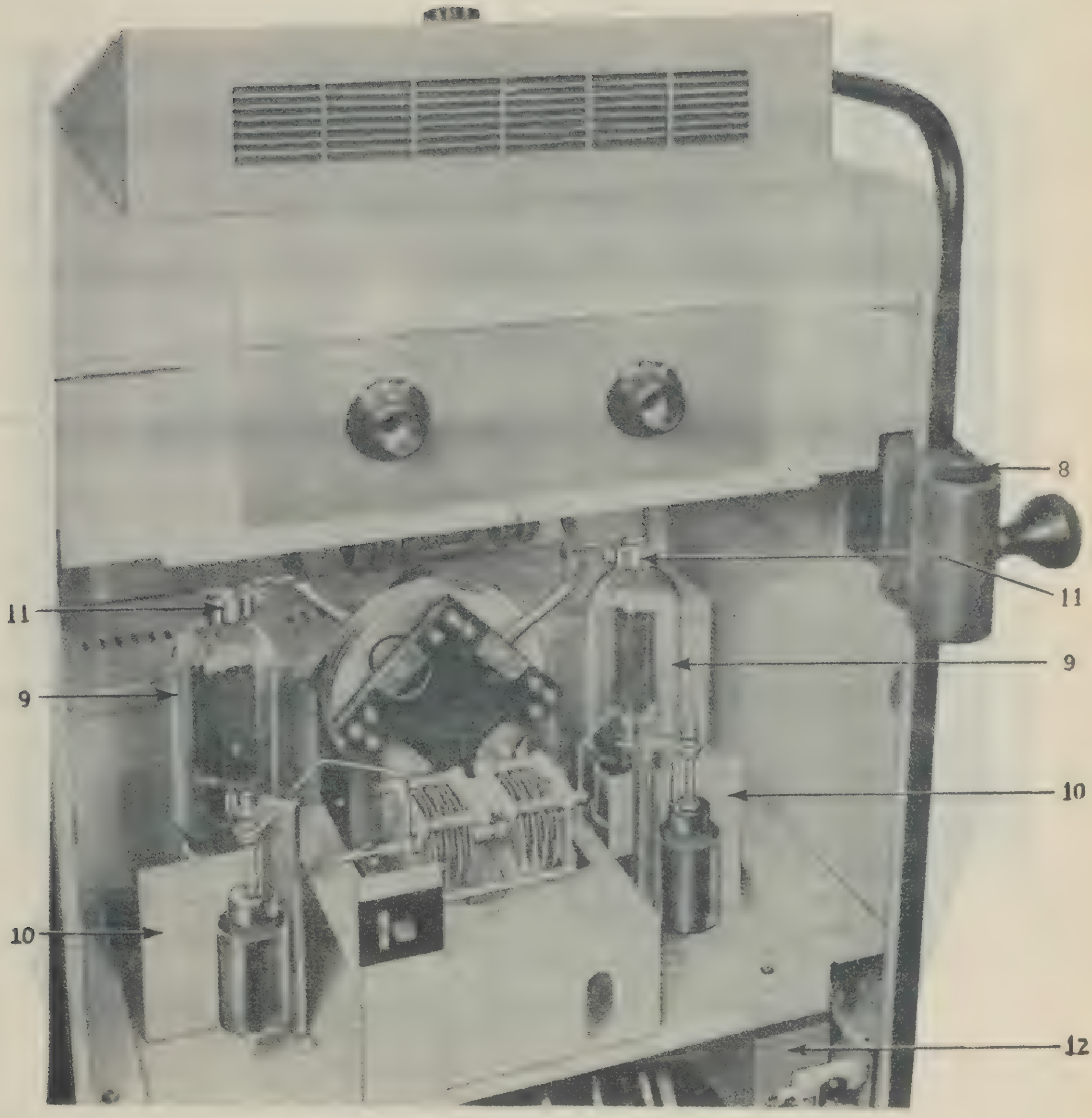


FIGURE 4

(8) Arm holder.
(9) FP-265 final amplifier tubes.
(10) Shield plates.
(11) Plate clips.
(12) Dust cover on relays.

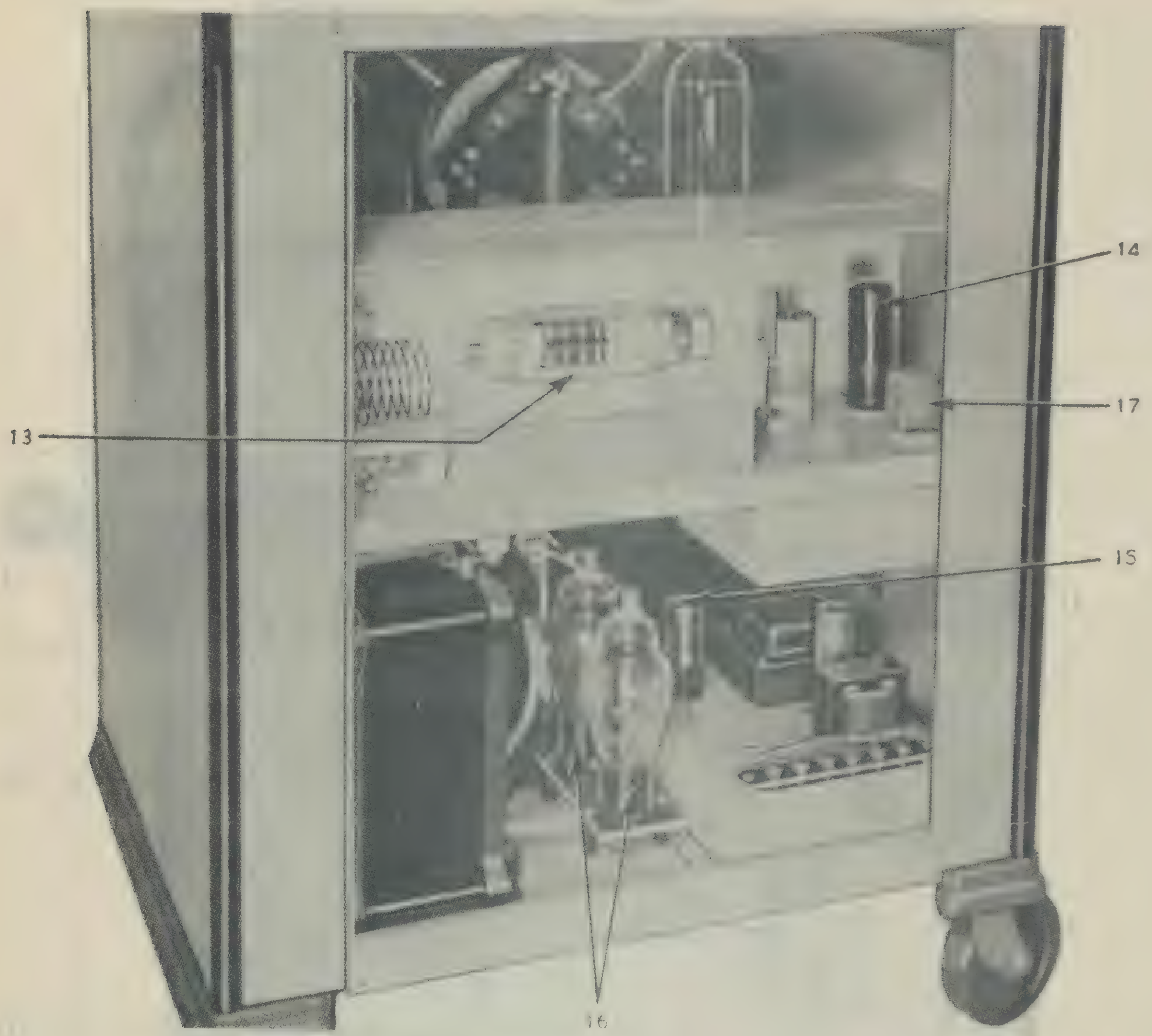


FIGURE 5

(13) GL-814 exciter amplifier tube.
(14) RCA-6L6 oscillator tube.
(15) RCA5Y3GT exciter power supply rectifier tube.
(16) RCA-866A high voltage supply rectifier tubes.
(17) Piezoelectric quartz crystal.

CONTROL PANEL

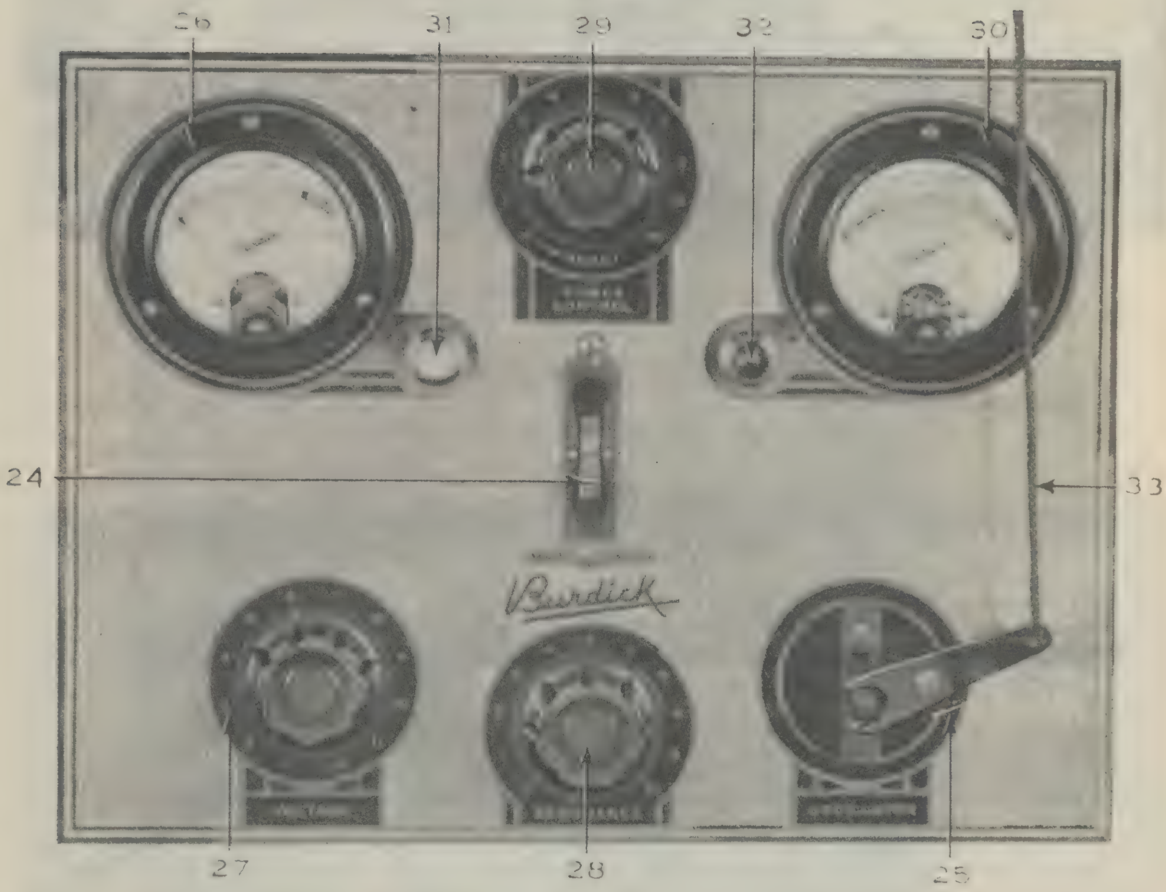


FIGURE 6

(24) Main Switch.
(25) Oscillator Switch.
(26) Voltmeter.
(27) Voltage Adjuster.
(28) Resonance Control.
(29) Power Control.
(30) Plate Current Milliammeter
(31) White Pilot Light.
(32) Red Pilot Light.
(33) Patient Pull-off Cord.

FIGURE 7A

FIGURE 7B
(22-23) Oil holes.

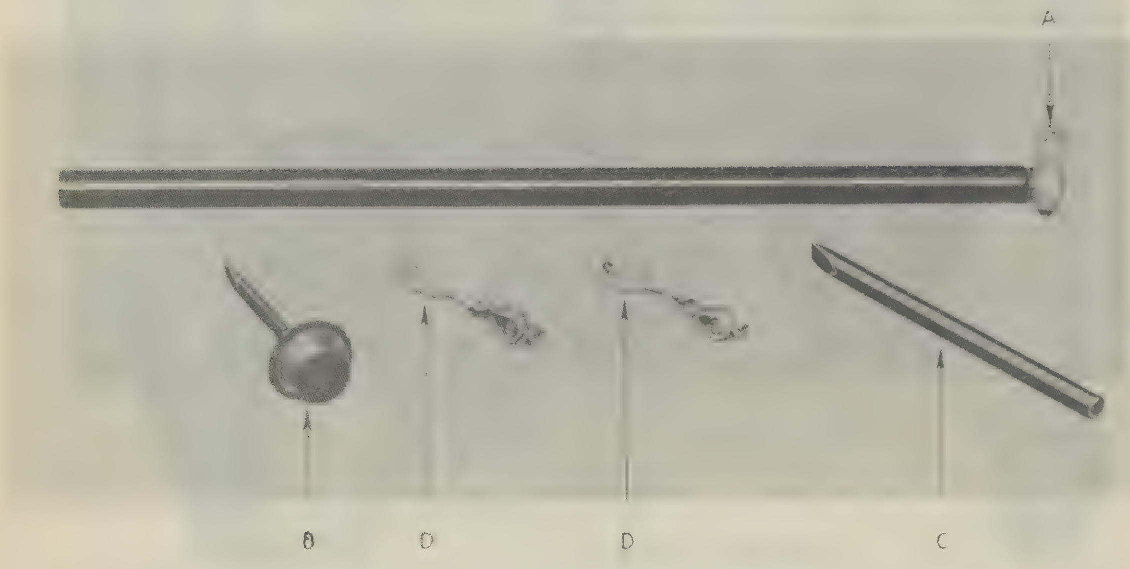


FIGURE 8

(A) 1/4 watt 115 volt neon glow lamp (T-4½ bulb) attached to the end of a 5/8" dia. by 18" long bakelite rod.

(B) 1/4" dia. by 2¾" long bakelite rod, with one end filed down to a wedge for a screwdriver, and with a bakelite knob on other end.

(C) 3/8" dia. by 7" long bakelite rod, with one end filed down to a wedge for a screwdriver.

(D) Two 1/4 watt 115 volt neon glow lamps (T-4½ bulb) with bases removed and attached to bronze clips. (Do not use steel clips).

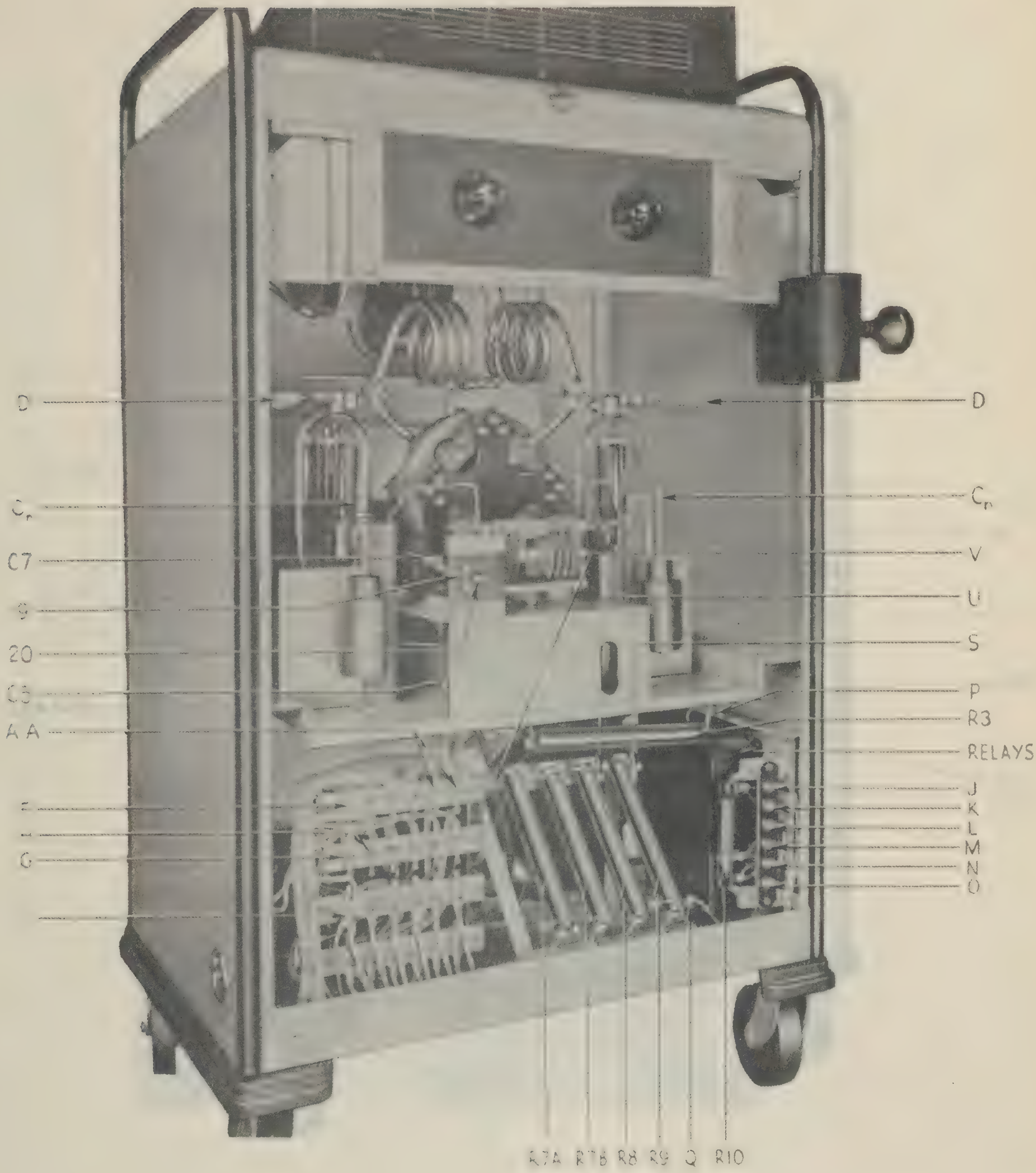


FIGURE 9

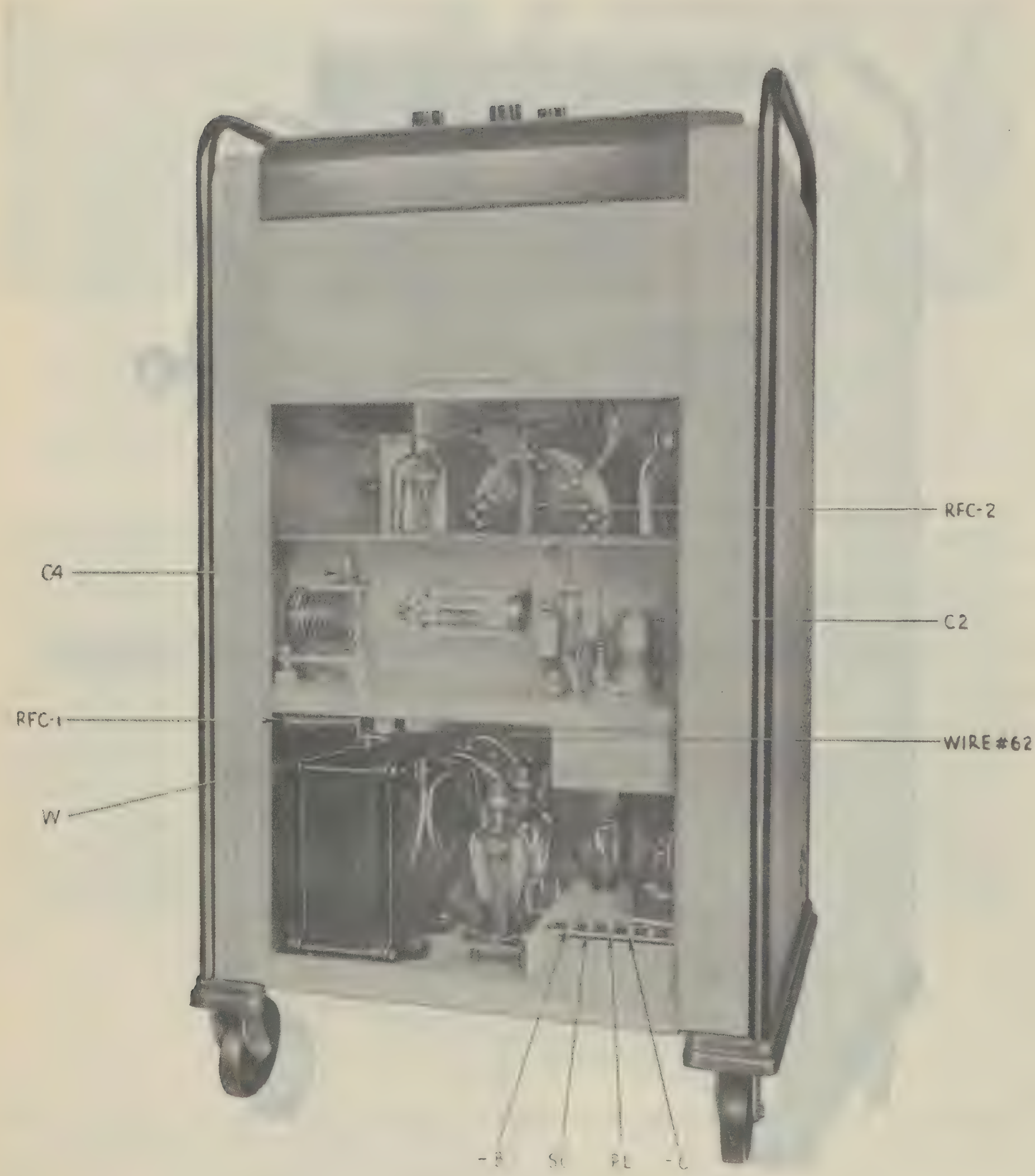


FIGURE 10

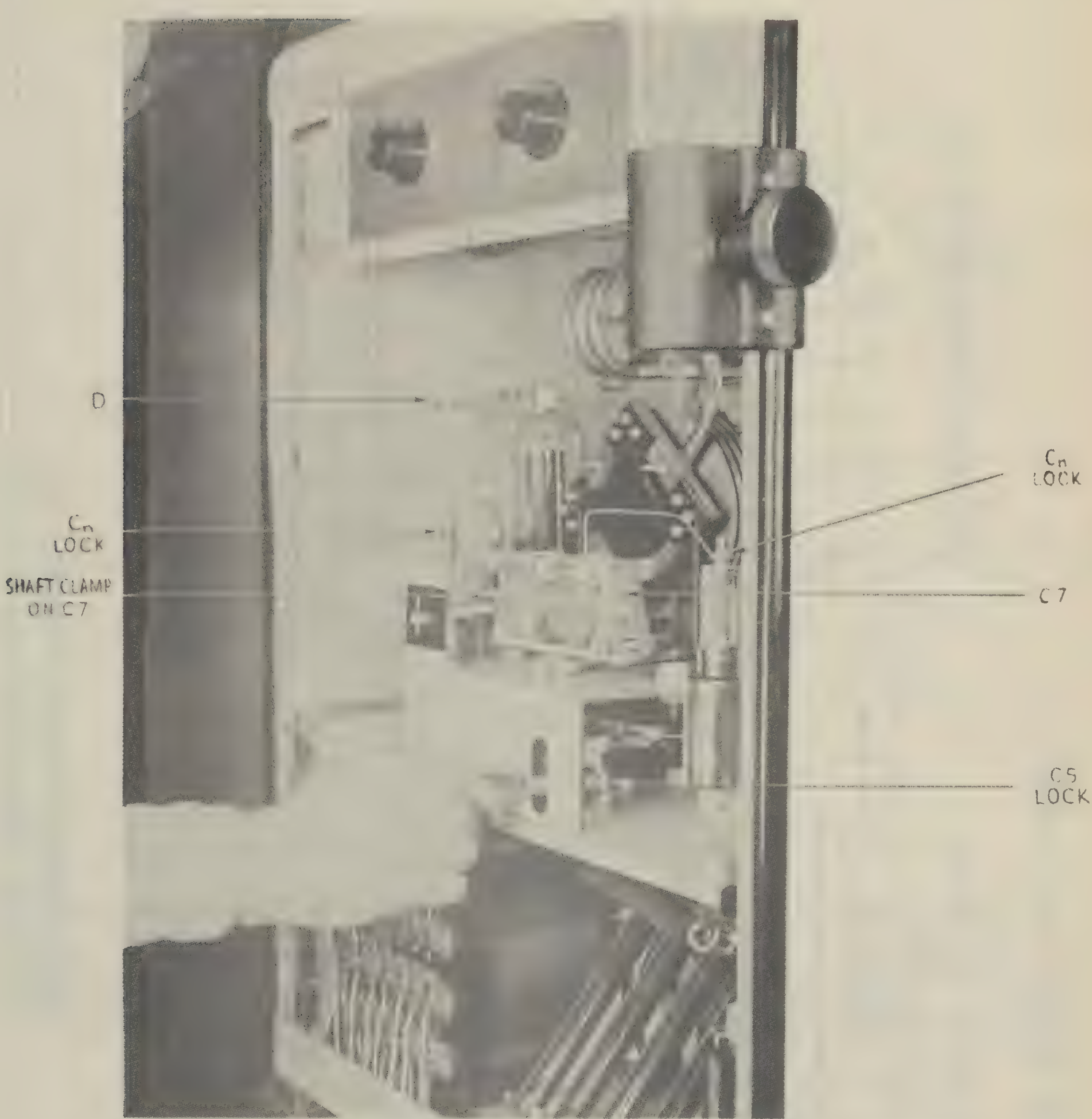
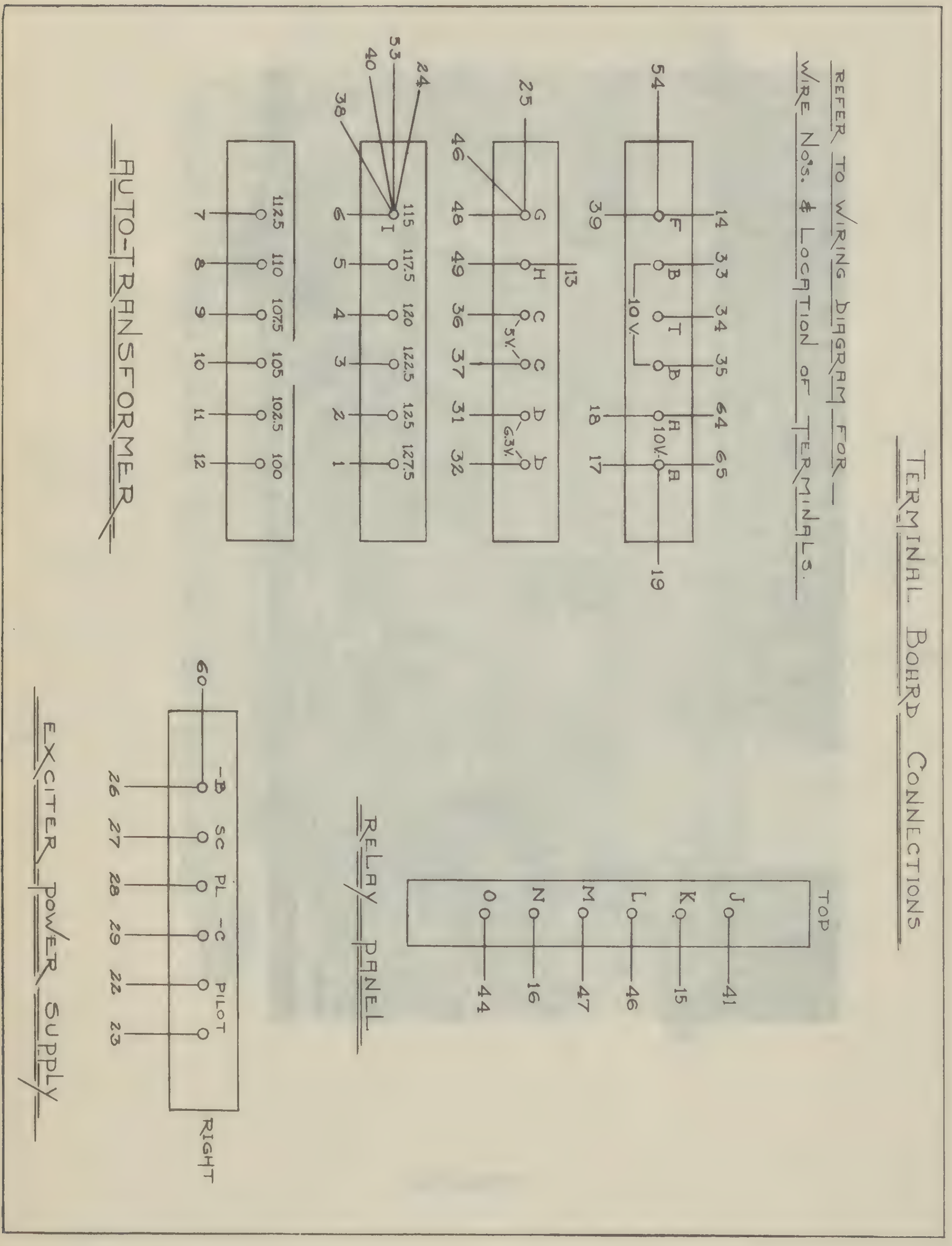
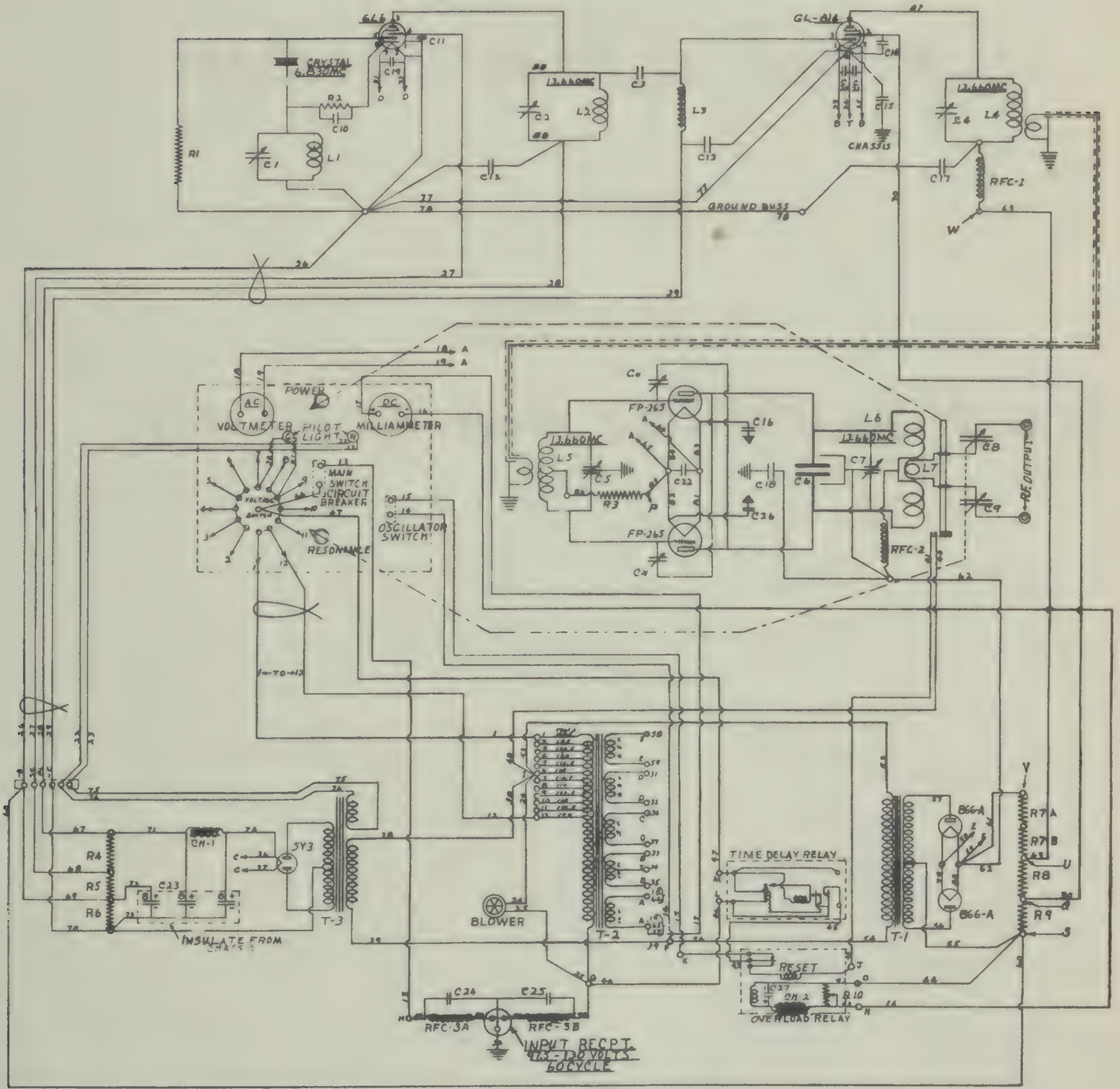


FIGURE 11


TERMINAL BOARD CONNECTIONS
REFER TO WIRING DIAGRAM FOR WIRE NO'S. & LOCATION OF TERMINALS.
AUTO-TRANSFORMER
RELAY PANEL
TOP
EXCITER POWER SUPPLY
RIGHT

SWDX-80 -CRYSTAL CONTROLLED DIATHERMY- 274



CHAPTER I

ELECTRO MEDICAL EQUIPMENT

SECTION 4

GALVANIC AND SINUSOIDOL UNITS

GALVANIC AND SINUSOIDOL UNITS

DIRECTIONS FOR MCINTOSH NO. 5018 PORTABLE WALL PLATE

ACCESSORIES - The compartment on the right hand side of the case contains the line cord, accessories and rectifier tube. The tube is packed separately for added protection in transport and should be CAREFULLY handled.

RECTIFIER TUBE - The rectifier tube, which converts the alternating current into a direct current, is of the full-wave, mercury vapor type. Each tube has been thoroughly tested and should operate efficiently for about 1,000 hours. In operation, the tube lights up, indicating that it is functioning. If, after extended continuous use, the voltage output of the rectifier drops, a replacement tube should be ordered and installed to again bring the apparatus up to its maximum efficiency. Upon receipt of the apparatus, the rectifier tube should be examined to see that it has not been broken or damaged due to rough handling in transit. Because of its sturdy construction, however, this possibility is quite remote.

CURRENT SUPPLY - Before connecting the apparatus to the current supply line, determine whether the supply current is an ALTERNATING or DIRECT CURRENT. (This information can be obtained from your local lighting company.) Adjust current selector switch stop accordingly to prevent turning of switch to the wrong side, thus safeguarding the unit against possible damage.

TO OPERATE ON DIRECT CURRENT it is NOT NECESSARY TO INSTALL RECTIFIER TUBE. Only the current forms on the RIGHT HAND SIDE of the Current Selector Switch CAN BE USED when this apparatus is to be operated on direct current. The currents thereby obtained with the exception of the secondary Faradic are NOT EARTH-FREE. Never attempt to use the current forms under ALTERNATING CURRENT when operating on a DIRECT CURRENT as it will injure this section of the circuit.

TO OPERATE ON ALTERNATING CURRENT it is necessary to INSTALL THE RECTIFYING TUBE by inserting it in its socket through the hole in the control panel. This tube will fit only ONE WAY in the socket with the HEAVY PRONGS TOWARD THE TOP of the apparatus. It is essential that the tube be pushed down tight to obtain proper contact. Only the current forms on the LEFT HAND SIDE of the Current Selector Switch under ALTERNATING CURRENT ARE TO BE USED when the apparatus is operated on ALTERNATING CURRENT.

METER - The milliammeter is provided with two scales. A scale selector switch, which is located on lower part of panel just above polarity switch, makes possible to select the desired scale. When a galvanic current of less than 12 milliamperes is required, snap the meter scale switch to "LOW" and read current on the 0 to 12 scale. THE METER WILL RECORD CURRENT ONLY WHEN GALVANIC CURRENT IS USED.

POLARITY - WHEN OPERATING ON DIRECT CURRENT the polarity may or may not be correct depending on the connection of the attachment plug to the direct current supply. TO DETERMINE POLARITY, set Current Selector Switch on GALVANIC FROM LINE, set meter scale switch on "HIGH" and see that rheostat is set at "OFF", connect the cord tips of either treatment cord to the patient binding posts, then turn rheostat on very slowly and note the direction to which the meter indicator points. If indicator points toward the right the polarity is correct. Should meter indicator tend to move toward the left of the zero mark the polarity is wrong and should be corrected by reversing the plug in the current supply socket. It is then advisable to again make the polarity test to be sure that the connection is correct. The attachment plug may be marked if desired so that future connections with that particular socket will be of the correct polarity. WHEN OPERATING ON ALTERNATING CURRENT, handle of polarity switch always points toward positive pole.

OPERATING - Before beginning treatment, set the Current Selector Switch

indicator to the desired Current Form. The pointer must always COINCIDE WITH LINE ON DIAL, set the meter scale switch to read the DESIRED SCALE, set rheostat at "OFF". At the conclusion of treatment, turn rheostat "OFF" slowly, disconnect the patient and set Current Selector Switch at "OFF".

GALVANIC CURRENT - The cords should be connected to the patient's binding posts, observing polarity. See that the meter switch is turned to "LOW". The current will be indicated on the 0 to 12 scale, which is the correct scale to use in electrolysis or light ionization. With the electrodes in place, turn the rheostat toward the right slowly until the meter registers the desired current quantity. The meter will not register unless the electrodes are applied to the patient so as to complete the circuit. The galvanic current obtained either with direct or alternating current is of ample strength for any galvanic treatment.

FARADIC CURRENT - This current (useful for muscular stimulation) is obtained in the same manner as the galvanic and its intensity is regulated with the rheostat. If the vibrator spring on the faradic coil does not vibrate evenly, it should be adjusted by turning thumb screw to the right or left until an even vibration is obtained. (Adjustments are NOT to be made when patient is under treatment with rheostat turned on.)

SINUSOIDOL CURRENT - Connect the patient the same as for galvanic and faradic current and regulate the intensity of the current with the rheostat. (NOTE: Faradic and Sinusoidol currents are not registered by the meter.)

IMPORTANT - Do not let the cord handles, pads or electrodes attached to the binding posts touch each other when the rheostat is turned on as the rheostat or meter may be damaged.

Before applying pads to patient, be sure that they are thoroughly saturated.

Never set pointer of Current Selector Switch to side not corresponding to your supply circuit.

Turn rheostat OFF before changing current forms, when patient is in circuit, to avoid shock.

Turn pointer of Current Selector Switch to "OFF" when through using the unit. Failure to heed this caution may cause burning out of transformer and unnecessary aging of the Rectifier tube.

Do not adjust faradic coil vibrator screw while patient is in circuit.

CHAPTER I

ELECTRO MEDICAL EQUIPMENT

SECTION 5-A

BURDICK - ULTRA VIOLET LAMPS

ULTRA VIOLET LAMPS

BURDICK

INSTALLATION AND OPERATION INSTRUCTIONS FOR PROFESSIONAL SPECIAL AIR-COOLED QUARTZ LAMP CATALOG QA-450-N

GENERAL - The ultraviolet generator (the burner) used in this lamp is the new self-starting type, known as an A.C. hot cathode lamp which contains a minute quantity of mercury in vacuum. The spectrum is similar to the old type quartz lamp.

The advantages of this type of burner over the former type are as follows:

1. Starts automatically, requiring no tilting.

2. Operates in any position.

3. Builds up to full efficiency in approximately four minutes.

4. Permits symmetrical mounting with reflector.

5. Provides uniformity in dosage as the radiation from this burner is relatively uneffected by supply voltage variation or by changes in room temperature of air currents.

The size reflector is designed to concentrate the radiation over an area the size of an ordinary treatment cot. It can be tilted to any position desired in the treatment of the patient and can be used horizontally as well as vertically.

The reflector is designed with shutters which should be closed during the build-up period of the lamp and opened as soon as the lamp is to be used for treatment. These shutters can be adjusted to any width or opening desired. If the friction shutter hinge ever becomes loose, it can be easily tightened with an ordinary screw driver.

A special built in tape is provided which measures the distance from the center of the burner to the patient. The lamp will produce ample ultraviolet radiation at a distance of 30 inches from the burner to the patient to produce a first degree erythema (mild reddening) on the average person after an exposure of 30 seconds.

The Burdick Professional Special lamp is manufactured to operate on alternating current only. Always check the current supply where the lamp is to be used to make sure it is in accord with the electrical information on the rating plate of the control cabinet.

UNPACKING - Before unpacking, be sure to inspect shipment; and if there is evidence of damage, a bad order receipt should be obtained from the transportation agent.

This is absolutely necessary in order to enter a claim for damages.

If, after unpacking, concealed damage is apparent, the proper officer should be immediately notified. This is particularly true of the burner. Failure to do this immediately forfeits your right to damages.

When unpacking the burner, do not remove the protecting paper until the burner has been installed in the lamp casing.

1. Place caster base on floor.

2. Remove the two wing nuts from the screw studs on the bottom of control cabinet.

3. Place control cabinet on caster base outside of lugs provided and allow the above mentioned screw studs to go through the two holes in the cast base.

4. Replace the two wing nuts on these studs on the bottom side of the base.

5. Next, lock the horizontal arm and carriage of the counterbalanced stand in a fixed position or allow it to carefully run to the top of the stand.

This precaution is to prevent the heavy counterbalance weight from suddenly running to the bottom of the stand when the column is raised to a vertical position for placing in the control.

6. Raise column up so that the bottom end may be placed in hole provided in top of the control cabinet.

This column will slide down through the control and into the cast base.

7. Tighten the set screw on under side of base against the lower end of column.

8. Remove large bakelite hand knob from horizontal lamp arm and insert arm in the ball bearing roller track. The "Burdick" trademark on the arm should be on the outside portion of arm.

9. Replace bakelite knob and tighten set screw in knob.

10. Remove hexagon nut and flat washer and spacer bushing from other end of horizontal arm.

11. Attach lamp hood to cross arm by placing the bracket on end of arm making sure locking handle is to the right when facing control cabinet, and replace spacing bushing and washer and hexagon nut, which should be drawn up tight.

12. A leveling screw is provided in a stud on the bottom side of the arm for the purpose of immediately locating a level position of the casing. If a fine level is desired, it may be necessary to readjust this set screw slightly.

13. The casing and counterbalanced stand may now be operated to see if all moving parts operate freely.

ASSEMBLY OF TUBE IN CASING - This quartz tube is the heart of the lamp and obviously is very fragile, therefore, great care should be exercised in handling it.

1. Be sure that the main switch on the control cabinet is turned off or the line plug disconnected before the burner is placed in the reflector. Remember that the clamps inside of the casing are both alive unless the current supply is turned off.

2. Loosen the knurled nuts on the burner clamps inside casing.

3. Slide the end of the burner with the flexible wire lead into the right hand clamp and push it through far enough so that the opposite end of tube clears the other burner clamp.

4. Next slide the tube back so that tube is evenly spaced in the two clamps, and tighten up the two knurled clamped nuts.

5. Attach the flexible wire lead from the burner to the binding post on the reflector near the right hand burner support.

6. The protecting paper may now be removed.

CARE OF THE QUARTZ TUBE - This quartz tube should be cleaned at regular intervals with the materials furnished with this lamp and the instructions closely followed which are provided on the cleaning kit.

This tube should never be operated until after all traces of dust and finger prints have been removed.

Failure to observe this will result in a clouded quartz tube which of course reduces the efficiency of the lamp.

ELECTRICAL CONNECTIONS - On the front of the control there is a removable panel for the purpose of parts inspection and making the proper tap adjustment for various line voltages.

It will be seen upon removal of this panel, that the tap wire is placed on the 115 volt terminal, as it leaves the factory, however, a lower or higher line voltage may be encountered and a change in the location of this one tap wire may be necessary.

The line voltage should be determined through use of a reliable volt meter or by information from the power company.

Too high a line voltage will shorten the life of the tube and too low a line voltage will reduce the ultraviolet output from the lamp.

OPERATION OF THE LAMP - Since the lamp has been completely assembled and the quartz tube carefully cleaned the lamp may be started as follows:

1. Plug casing cord plug into rear receptacle of control cabinet.

2. Turn main switch on top of control cabinet to "OFF".

3. Plug line cord plug from the control cabinet into the proper current supply. (Observe rating on top of control.)

4. Turn main switch to "ON" position.

5. The burner should now light.

6. Allow 4 minutes for burner to "build-up" before starting treatment. If lamp is equipped with a meter, the indicator will be at about 5 when the lamp is started and drop back into the red area after the lamp is built up.

This build-up period may be slightly reduced by closing the shutters on the casing during the build-up period.

The main switch on this quartz light should never be turned to "ON" position unless the operator is absolutely sure that the tube is tightened up in the tube clips and also that the lamp cord is plugged into the control cabinet.

SERVICE SUGGESTIONS - If after the lamp is assembled and the quartz tube is put in the casing and the lamp fails to start, the following check up should be made.

1. Check power or light outlet with some kind of test lamp to make sure outlet is O.K.

2. Make sure outlet is not D. C.

3. Test to determine if current is reaching the burner by placing a 300 volt A.C. voltmeter across the burner terminals when the switch is on. A normal no load voltage reading will be approximately 250 to 260 volts.

4. If there is no voltage on burner terminals examine Uviarc cutout (Small cylindrical shaped thermal switch in base of lamp) as it may be loose in socket or have been damaged in shipment. The latter condition can be determined by trying a new Uviarc cutout.

5. If there is voltage on the burner terminals then look closely at right end of burner and see if there is a dim bluish glow at that end. If there is no glow then examine Uviarc cutout in base of lamp as explained in paragraph 4.

6. If there is voltage on the burner terminals and the right end glows as described above but will not start, then the burner has apparently been damaged in transit and a concealed damage report should be made to the proper authority.

CAUTION - The Main Switch on this quartz light should never be turned to "ON" position unless the operator is absolutely sure that the tube is tightened up in the tube clips and also that the lamp cord is plugged into the control cabinet.

Model QA-450-NH (Item 71260) is equipped with handle bars. The base of the control unit is drilled to accommodate these handle bars which are installed as follows:

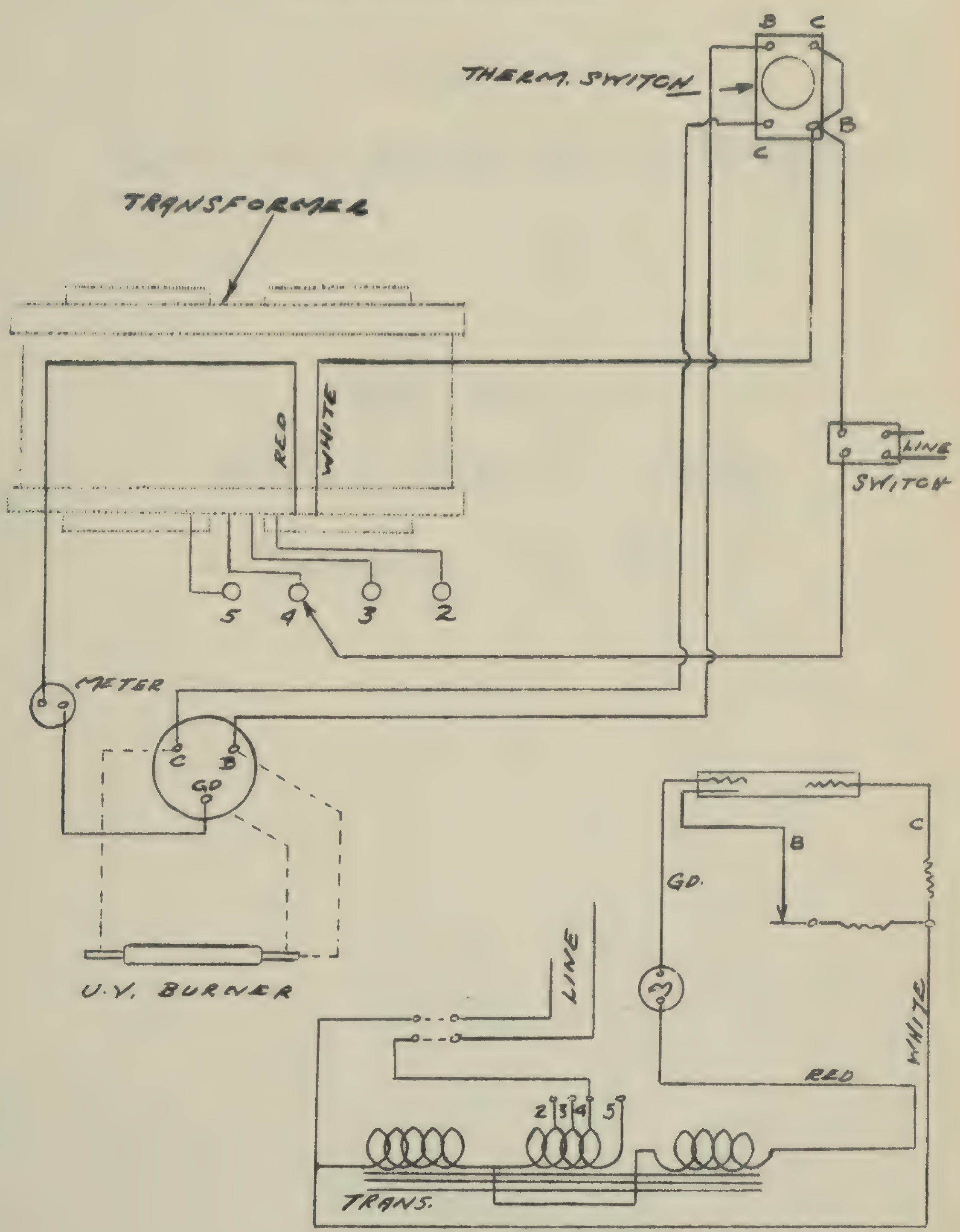
1. Loosen the large set screws located underneath base (one at each hole).

2. Place handle bars in the two holes so that they slant away from the fronts of the control.

3. Make sure the handle bars are down to the bottom of the holes and then tighten set screws.

WIRING DIAGRAM

QA-450-N LAMP



SCHEMATIC DIAGRAM

CHAPTER I

ELECTRO MEDICAL EQUIPMENT

SECTION 5-B

ULTRA VIOLET LAMPS

- GENERAL ELECTRIC -

GENERAL ELECTRIC MODEL F

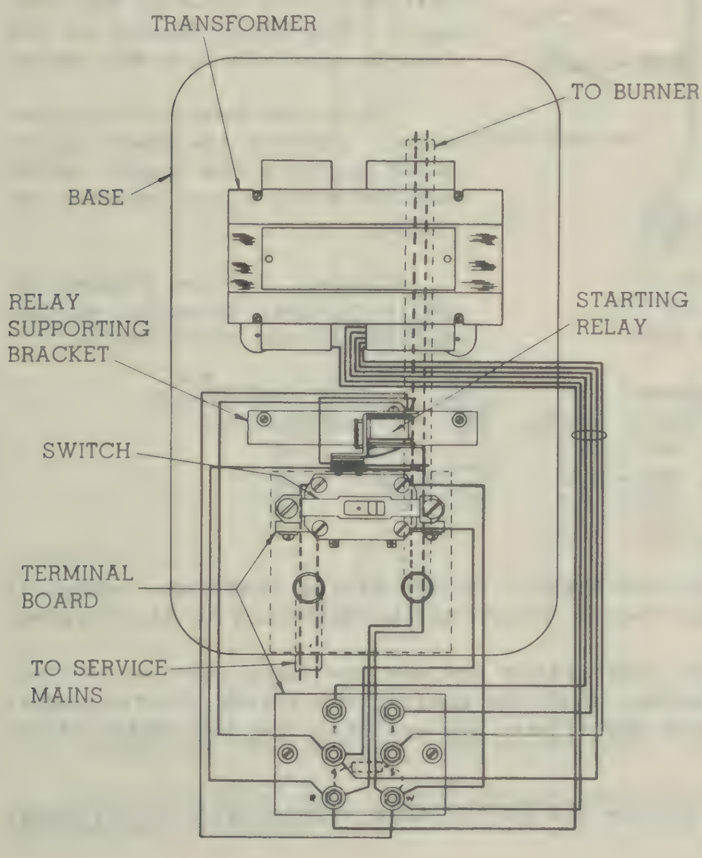
This quartz-mercury lamp incorporates the latest scientific contributions for the production of ultraviolet radiation. Physically small, and requiring little floor space in the office or hospital, it generates ultraviolet radiation equal to that of any lamp of its class. Operating at high efficiency direct from alternating current and having no controls or regulating devices other than a simple "on-and-off" switch, there remains little possibility of damage due to improper operation, and the absence of moving parts practically eliminates probability of its requiring service until the burner has served its normal life and requires replacement.

While the lamp is so simple as hardly to need instructions for operation, a thorough understanding will aid in obtaining maximum usefulness. This booklet, therefore, should be read carefully before the lamp is placed in service.

The G-E Model F Ultraviolet Lamp is available in two models, one a mobile model designed primarily for the office, clinic, or hospital where mobility and adjustment of the treatment distance is desirable; the other designed expressly for the solarium where the burner housing and control may be permanently installed.

MOBILE MODEL - In the mobile model the special transformer and starting relay required for operation of the burner is mounted in the base, and its weight is sufficient to keep the lamp from being readily upset.

An adjustable telescopic tube column permits the burner to be positioned at any height from the floor between approximately 4 feet 10 inches and 7 feet. A steel spring within the column provides partial counterbalance. A slight effort will be required to raise the lamp to its highest position and it will have to be pushed down to the lowest. It may be locked in the desired position by turning the thumb screw located at the top of the stationary column.



The burner housing may be angulated to any position from vertical to horizontal. A friction locking-lever immediately behind the housing controls this movement.

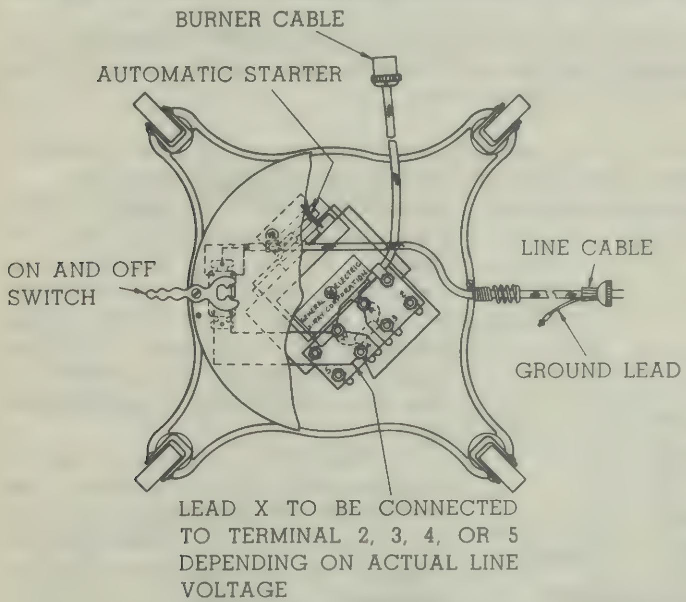
The burner is of entirely new design. Cylindrical in shape, it offers a minimum of obstruction to the radiation. It contains a few milligrams of mercury which is completely vaporized at operating temperatures, resulting in stability and steady output. It is not affected by normal line fluctuations, nor does its operation change by opening or closing the shutters.

Shutters are provided to serve a two-fold purpose. They may be used to reduce the width

of the field of radiation or to shut off the radiation entirely without turning off the burner. This is a convenience when treating several patients successively.

As the intensity of the radiation varies inversely as the square of the distance between the burner and the patient, it is important that the correct treatment distance be used. A steel measuring tape built into the burner housing permits this to be determined easily. The tape should be pulled out until the knob touches the patient. The reading on the tape at the point where it enters the housing then indicates the distance between the patient and the burner. For convenience the "on" and "off" switch is located in the base of the unit where it is easily operated with the foot. A white dot on the base unit indicates the "on" position.

INSTALLATION OF MOBILE MODEL - The lamp is dismantled and packed in four parts for shipment. Unpack carefully and preserve the packing until you are sure all parts have been accounted for. In addition to the lamp proper, there should be two pairs of ultraviolet goggles and, packed with the burner, should be a two-ounce can of acetone for cleaning purposes.



Determine the actual voltage at the receptacle to which the lamp is to be connected and make certain that both voltage and frequency correspond to that stamped on the nameplate of the Model F lamp. This nameplate is affixed to the side of the base unit. The power demand of the lamp is approximately 400 watts.

Turn the base unit on its side. Remove the foot lever which operates the toggle switch and the metal plate covering the bottom.

Connect the lead stamped "X" to the proper terminal as indicated in the table below:

Actual line voltage		Place lead "X"
115-v. units	230-v. units	on terminal
100 - 104	200 - 209	2
104 - 111	209 - 223	3
111 - 118	223 - 237	4
118 - 125	237 - 250	5

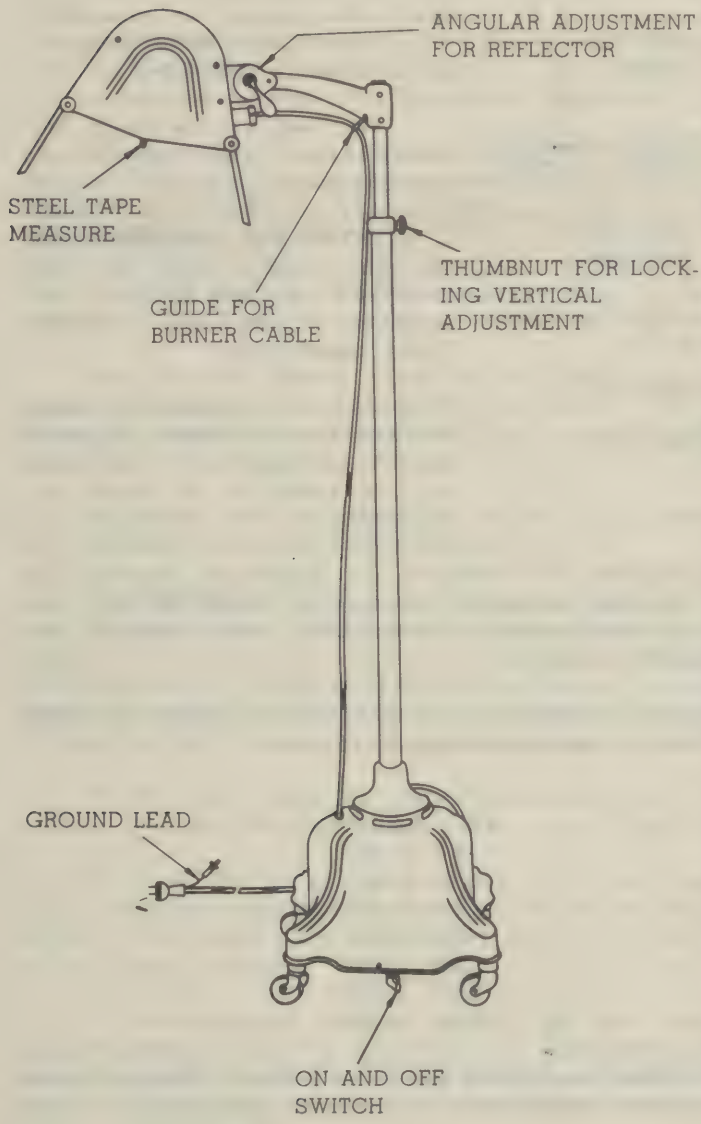
Make sure all terminal nuts are tight. If any of the leads have come off during shipment, proper connection can be determined by reference to the diagram.

Replace the cover plate and foot lever and set the base unit on its four casters. Place the telescopic column, with the long spring inside, in the socket in the base unit. Line up the holes and tighten the screws in the top center of the base to secure the column.

Attach the burner housing to the arm on the tube column with the fittings provided.

On the burner cable is an eyelet. This should be pushed into the hole provided for it on the underside of the arm and secured by tightening the set screw. This keeps the cable away from the housing.

Wipe the reflector with a clean, soft dry rag.



Clean the burner by wiping carefully with a clean rag moistened with acetone.

CAUTION - Handle the burner by the metal electrode guards only.

Fingerprints, if not removed from the burner before it is operated, will burn into the quartz and permanently impair the efficiency of the burner. If, for any reason, the burner is touched, carefully clean it again with acetone before starting the lamp. DO NOT USE ACETONE NEAR AN OPEN FLAME AS IT IS INFLAMMABLE.

Place the burner in position by carefully pushing it into the clips provided, as shown in the illustration on the following page. The seal-off "tip" of the burner is placed at the end away from the center clip in order to avoid the possibility of breaking off the tip. Note that the center clip does not make contact with any metallic part. The burner should be positioned so that the clearance between the center clip and the nearest electrode guard is from 1/2 to 3/4 of an inch.

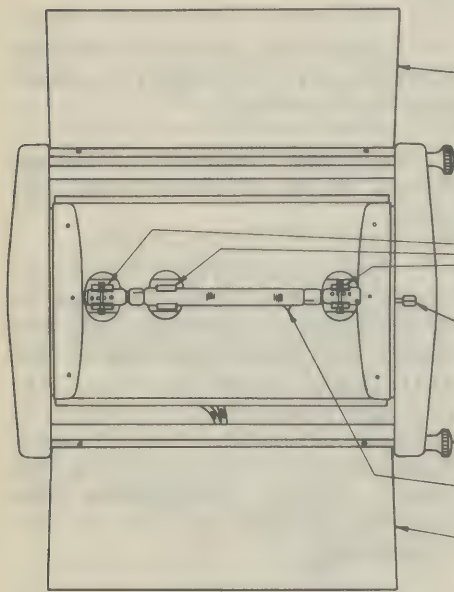
Tighten the knurled screws in the slots provided in the two end clips, so that proper contact will be maintained at this point.

Pull out the steel tape and place it in the slot in the housing directly below the tape reel.

Place the "on" and "off" switch in "off" position.

Plug the line cord into a convenience outlet previously tested for correct voltage and frequency.

The lead extending from the attachment plug and terminating in a ground plug is for grounding the mobile unit.



NOTE - One of the screws holding the convenience outlet face plate of a grounded conduit system can be removed and this ground plug screwed in. Make sure conduit is grounded; if it is not, then separate ground must be provided.

The lamp is now ready for operation. (See operating directions.)

OPERATION - To start the burner, simply turn the "on" and "off" switch to the "on" position. The burner should light immediately.

Allow a minimum of four minutes for the burner to reach operating condition. The lamp is now ready to be used for treatment.

The burner operates the same whether the shutters are opened or closed. If only a short interval is to elapse between successive treatments, close the shutters rather than turn off the burner. If the burner is turned off, approximately six minutes must elapse before it can again be started.

The area covered by the ultraviolet radiation is determined by the distance from the burner to the patient. This is approximately as follows:

Distance Burner to Patient	Area Covered
24"	36" x 48"
30"	42" x 60"
36"	50" x 72"
48"	67" x 96"
60"	84" x 120"
72"	100" x 124"
84"	120" x 168"

From this table determine the burner-to-patient distance desired. To determine the length of conduit required to support the housing, proceed as follows:

x = burner-to-patient distance desired (in inches).

y = patient-to-floor distance (in inches). This will not be constant as the thickness of patients differs. For practical purposes, consider an adult as 9" thick or a child as 6" thick and add this to the height of the table or couch to be used in treatment.

z = ceiling height (in inches).

Length of conduit $z = (x + y) = 6$ where 6 inches is the distance from the center of the burner to the end of the housing mounting bracket plus the ceiling flange thickness less one and one-half inches for threads.

Example - x = 60" burner-patient distance desired.
y = 30" height of table (24") plus thickness of child (6").
z = 9'-6"   floor-to-ceiling height   114 inches. Therefore length of conduit   114 - 90 - 6   18 inches.

PERTINENT SUGGESTIONS - In the case of the mobile model, always use the steel tape to determine treatment distance. A slight change in treatment distance results in considerable change in ultraviolet intensity.

Protect the eyes of your patient by always having him wear the ultraviolet goggles furnished with the equipment. Looking directly at the burner for even a short time without protecting the eyes may produce an uncomfortable or dangerous conjunctivitis.

Protect the eyes of the operator also if he is to be about the patient frequently. Too long in reflected radiation may result in conjunctivitis.

An interval timer, which may be purchased as an inexpensive accessory, is a convenient device for timing the treatment. An automatic electric timer can also be supplied which will turn off the burner at the end of the time for which it is set.

Maintain your apparatus as called for in these instructions. It will pay you in increased life and efficiency.

MAINTENANCE - The only maintenance required is to keep the lamp clean. During use, a dirty deposit may accumulate on the reflector near the burner. This can usually be removed by wiping with a soft clean rag. The reflector may be cleaned with Bon-Ami or other mild cleansing power or silver polish. Do not let water or cleansing agent run back through the holes in the top of the reflector. Do not use a harsh or gritty cleansing agent, as the reflector may be damaged.

At the same time, the burner should be carefully wiped with a clean rag moistened in the acetone furnished. The burner should not be removed for this cleaning.

If the lamp is moved to a new location, the line voltage should be measured and a tap change made if necessary, as called for in the section covering installation. This must also be done if for any reason the line voltage at a given location should change.

If the measured voltage is near the lower end of the range for any tap and the burner goes out during operation or frequently fails to start when the switch is closed, change lead "X" to the next lower voltage tap. This change should not be made if the burner operates satisfactorily when connected as shown in the installation instructions.

DIRECTIONS FOR INSTALLING STARTING RELAY ON MODEL "F" ULTRAVIOLET LAMP

1. The starting relay is furnished mounted to its supporting bracket (see Fig. 4 of Starting Relay Diagram) and with the necessary wires for connecting it, already attached. The leads are cut to the proper length and the cord tips which are

attached have been stamped to correspond to the markings of the terminals to which they shall be connected.

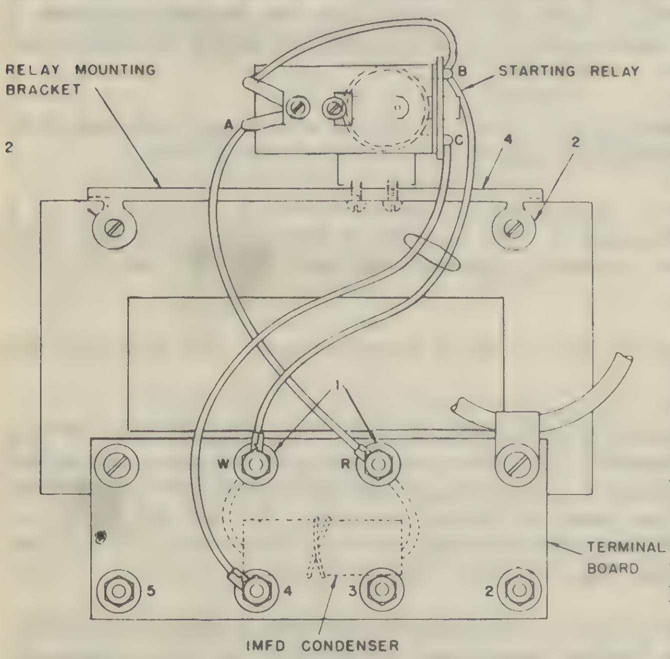
2. The starting relay shall be installed in accordance with the following directions.

3. Remove the circular metal plate from the bottom of the lamp, by taking out the five machine screws which secure it in place.

4. Remove the two leads connecting terminals "W" and "4" from the toggle switch on the metal plate. This will permit the metal plate to be pulled back out of the way while installation of the relay is being made.

5. All wires connected to terminals "W" and "R" shall now be removed and the terminals themselves shall be removed from the terminal board.

6. Two 3/4" - 10-32 machine screws are furnished which shall be used as new terminals "W" and "R". As shown in the illustration, the 1/10 mfd. tubular condenser shall be connected between terminals "W" and "R" and tied in position underneath the terminal board. The leads of the 1/10 mfd. condenser are equipped with cord tips, which shall be installed over the terminal screws, between the head and the terminal board on the underneath side. A washer shall also be placed on the terminal screw over the cord tip. Secure the terminals so the board with a washer and locking nut in the same manner as the other terminals.



STARTING RELAY WIRING DIAGRAM

7. The starting relay shall now be mounted to the frame of the transformer in the manner shown in the illustration. Holes are provided in the supporting bracket which line up with the slots in the transformer frame, and the two 1/2"-10-32 R.H.M.S. washers and lockwashers, Fig. 2, are supplied. Fasten this bracket in position securely.

8. The leads which have been removed from terminals "W" and "R" shall now be replaced on their respective terminals. Connect the lead attached at "B" on the relay to terminal "W" on the terminal board, and the lead attached to "A" to terminal "R". Anchor all leads on terminals "R" firmly in place with the hexagon nuts Fig. 1.

9. The lead connected at "C" on the starting relay shall now be connected to terminal "R" on the terminal board.

10. Connect the two leads attached to B and A of the switch to terminals "W" and "4" respectively and tighten all terminal nuts down firmly.

11. The cable clamp on the base plate which holds the cable entering the line switch in position shall be loosened and turned around to a position 180° out of its present position and then tighten over the cable in the same manner as before. This completes the installation and the base plate shall now be reinstalled on the base of the lamp.

DIRECTIONS FOR INSTALLING NEW STYLE BURNER CLIPS IN THE MODEL "F" ULTRAVIOLET LAMP

In those cases where the new style clips have not been provided it is

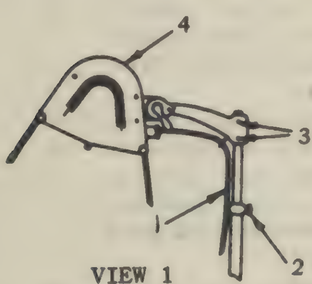
suggested that they be installed to provide better contact to the burner electrodes which will assure proper operation of the burner.

To replace the burner clips it will first be necessary to remove the burner support, View 2, as follows:

The first step will be to open the shutters and take out the burner.

Disconnect the cable Fig. 1, from the burner housing. Lock the tube column in place by means of the thumbnut Fig. 2, View 1. Remove the two screws Fig. 3, and lift the burner housing from the tube column. Place the burner housing on soft waste or padding material so as not to mar the finished surface, and remove the outer metal shield Fig. 4 by means of the eight binding head machine screws. This will give access to the burner support, Fig. 5, View 2, which can then be removed.

Revove the old end burner clips and the auxiliary clips Fig. 6. Reinstall auxiliary clips Fig. 6 and install the two new slotted end clips Fig. 9 which are furnished.

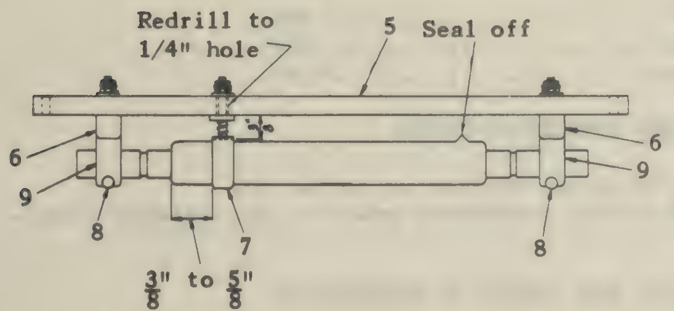


VIEW 1

Redrill the mounting hole to 1/4" diameter.

The new center clip shall then be installed as shown in View #2. Place the small coil spring over the round shank of the clip and then one of the washers furnished. Insert the threaded portion through the burner support. Next place the other washer over the threaded portion and install one of the hexagon nuts, turning it up as far as possible. Lock this nut in position using the additional nut and lock washer provided.

The burner support Fig. 5, shall again be fastened in place, the connections made to the terminals and the sheet metal cover Fig. 4 View 1, replaced. The burner housing shall be fastened to the tube column and the cable Fig. 1, connected.

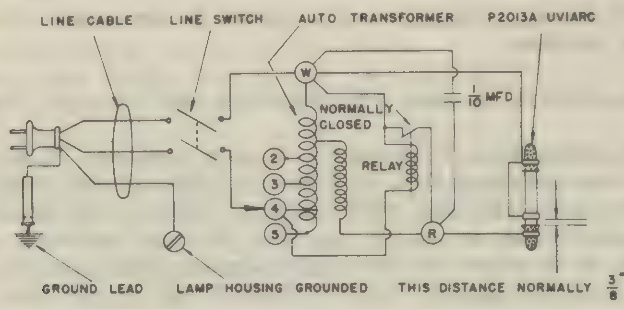


VIEW 2

Wipe the reflector with a clean, soft, dry rag, clean with Bon-Ami if necessary. Clean the burner by wiping it carefully with a rag moistened with acetone. *CAUTION:* Handle the burner by the metal electrode guards only, for fingerprints, if not removed from the burner before it is operated, will etch into the burner and permanently impair the efficiency of the burner. If for some reason the burner is touched, carefully clean it with acetone before starting the lamp. DO NOT USE ACETONE NEAR AN OPEN FLAME AS IT IS INFLAMMABLE.

Place the burner in position by carefully pushing it into the clips, as shown in View 2. The seal-off "tip" of the burner is placed at the end away from the center clip in order to avoid the possibility of breaking off this tip. *NOTE:* that the center clip does not make contact with any metallic part, and the burner should

be positioned so that the clearance between the center clip, and the metal electrode guard is from 3/8" to 5/8" as shown in View 2. The knurled screws, Fig. 8, shall then be used to permanently lock the burner in position.



SCHEMATIC DIAGRAM FOR MODEL "F" ULTRAVIOLET LAMP
(WITH AUTOMATIC STARTER)

MOBILE MODEL

WEIGHT

50- or 60-cy. unit.......approx. 85 lbs.
25 cy. unit..............approx. 100 lbs.

RATING

Nominal Voltage - 100/125 or 200/250
Nominal Frequency - 25-, 50- or 60-cy. (within 2 cy.)

Line Current - approx.		6.0 at 115-V. 60-cy.
(stabilized)	"	2.0 at 225-V. 60-cy.
	"	7.0 at 115-V. 25-cy.
	"	3.5 at 225-V. 25-cy.

Burner current - approx. 2.7 amps. after stabilization or 4.5 amps. at start.
No load burner voltage - 222-V. with 115- or 230-V. across taps "W" and "4".
Load burner voltage - 136 10-V. (after stabilization).

Burner watts.......................360
Line watts.........................410
Power factor.......................0.80

WIRING SPECIFICATIONS

Line - #14 A.W.G. conductors for power service up to 100 ft.

For solarium installation #14 A.W.G. conductors must be used between transformer and ceiling outlet.

DIFFICULTIES AND THEIR ELIMINATION

Q. - *The burner goes out after a consistent period of time.*
A. - Gas pocket within tube caused by vaporization of tube elements or leaky tube. Replacement of tube is the only permanent solution. May be helped by increasing burner voltage. Check transformer output.

Q. - *The burner goes out inconsistently.*
A. - Due to open circuit either in line supply or lamp connections, burner contacts or burner housing receptacle.

Repair loose connection.
A badly fluctauting line may cause the burner to drop out. The remedy here is to provide a line that does not have heavy loads being alternately placed on and taken off of it.
Check transformer output.

Q. - *Has poor starting characteristics.*
A. - If the unit has an automatic starter first check it to see if it is opening when voltage is applied. Then check burner. If the lamp has no starter, install one. Starting is benefited by shifting the burner in the clips. The distance between the left hand electrode and the closest point of the middle electrode should be approximately 3/8" to 5/8". If the above does not remedy the trouble, move the variable lead "X" on the autotransformer to the next lower tap. This, however, should not be done unless necessary for it applies a higher voltage on the burner and decreases its life. *NOTE:* Lamps with serial numbers 127179 and lower do not have automatic starters unless they have been installed since that lot.

Q. - *Fails to reach normal brilliancy.*
A. - Burner faulty. Replace.
Transformer secondary voltage limited.
High resistant connection.

Q. - *Radiation output impaired.*
A. - Possibly due to devitrification of the burner from handling (clean with acetone once weekly), or improper reflection from chrome matte finish of housing due to improper cleaning (clean once weekly with Bon-Ami). 20% of radiation should be below 3000 A (an Angstrom unit is 1x10-8cm).

Q. - *Glass etched under center clip.*
A. - Due to poor contact. Should install new style spring clips to afford better contact (see instructions for installing new style clips).

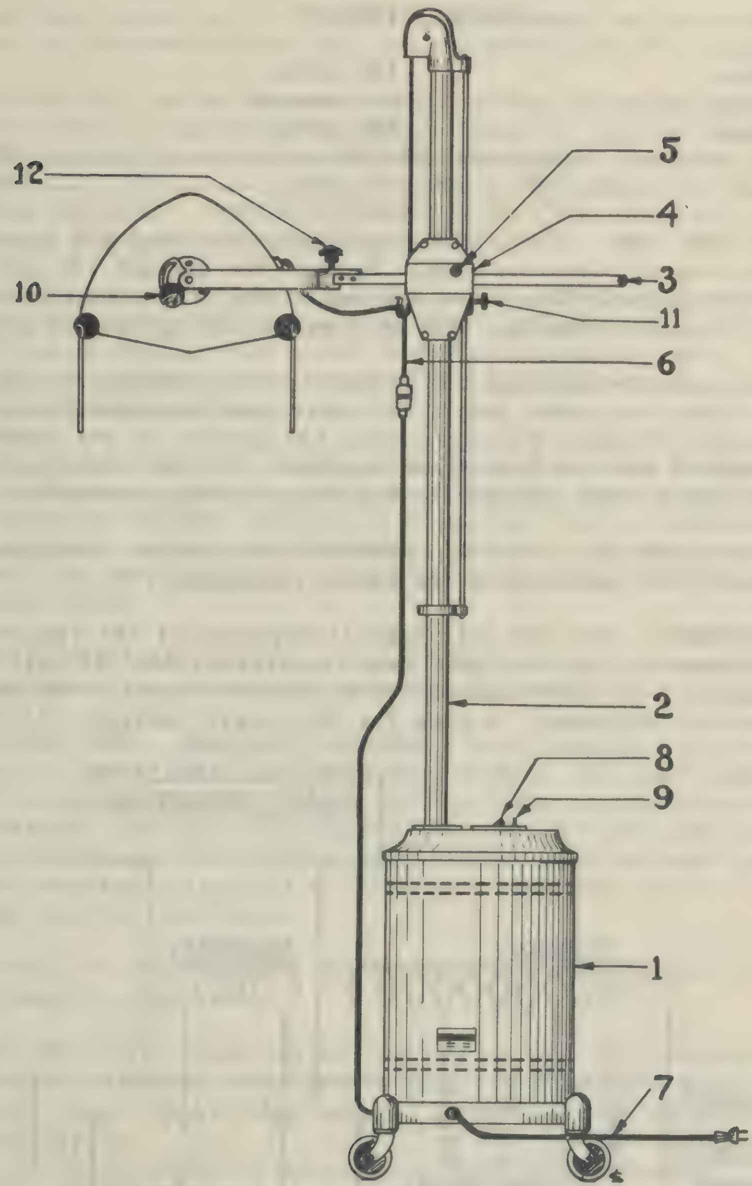
CHAPTER I

ELECTRO MEDICAL EQUIPMENT

SECTION 5-C

HANOVIA - ULTRA VIOLET LAMPS

HANOVIA



HANOVIA ALPINE LAMP ALTERNATING CURRENT

ELECTRICAL CHARACTERISTICS

Lamps must be connected only to supply voltage and frequency specified.

	Model S-2307-A . . . 110 Volt Lamp	Model S-2305-A . . . 220 Volt Lamp
Supply Voltage (See Voltage Adjustment)	100 to 130 volts	200 to 250 volts
Fuse Size on Supply	30 amperes	20 amperes
Starting Current	(at 105 volts) 18 amperes	(at 205 volts) 10 amperes
Operating Current	(at 105 volts) 13.5 amperes	(at 205 volts) 7.5 amperes

BURNER CIRCUIT

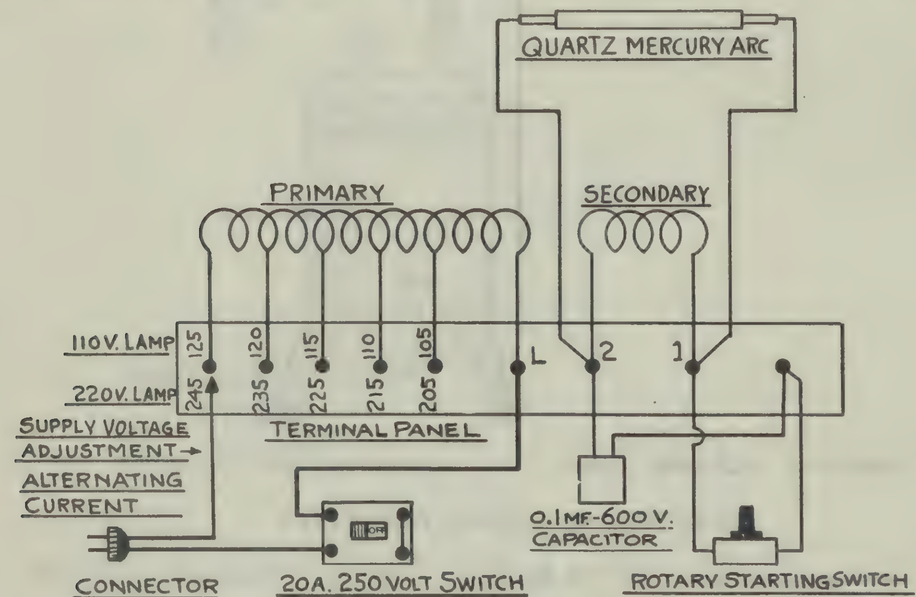
Burner Voltage	140 volts
Burner Current	4.5 amperes
Burner Wattage	550 watts
Transformer Secondary Voltage with NO-LOAD	280 volts
LOAD Wattage (for either 110 or 220 volt Lamp)	650 watts

TO ASSEMBLE THE LAMP - Place the transformer housing (1) upon the floor in its normal position with casters down. Procure the upright (2) and insert the lower end into the receptacle located in the top of the transformer housing. Lower the upright until it seats properly. This will secure the upright in position.

Mount the hood upon the carriage and upright. Remove two screws (3) located at the extreme end of the cross arms, insert the cross arms horizontally into the wheel track of the carriage (4) until the screw holes (3) project on the opposite side of the carriage. Replace the two screws and tighten. If the cross arms should not move freely in the wheel track, loosen the horizontal locking screw (5).

Attach the electric cord from the transformer housing to the short cord from the hood (6). Attach the lamp cord to the supply receptacle (7).

VOLTAGE ADJUSTMENT - The 110 volt lamp is adjusted at the factory for operation on 115 volt supply. The 220 volt lamp is adjusted for 225 volt supply. If the supply voltage differs from these values by more than + or − 4%, the lamp will give better service if adjustment is made for the supply voltage. As indicated in



ELECTRICAL CIRCUIT
HANOVIA ALPINE LAMP

the wiring diagram, a panel with terminals for voltage adjustment is provided on the transformer located within the transformer housing (1). When making voltage adjustment, it is required only that ONE wire be moved. If, for example, the

110 volt lamp must operate on 110 volt supply, move the wire from the terminal marked 115 to the terminal marked 110. Do not permit any other wiring alterations.

Operation of the lamp on improper supply voltage adjustment will result in more rapid deterioration of the burner if the voltage be too high, and if too low, in lowered efficiency and possibly starting difficulties.

CLEANING THE LAMP - *BEFORE ATTEMPTING TO START THE LAMP*, read carefully these burner and reflector cleaning instructions.

A dirty reflector will result in much lower efficiency. Metal polishes must *NOT* be used on the reflecting surfaces as they will probably spoil them. Instead, dust the reflectors lightly with a soft slightly moistened cloth. Do not rub hard, and do not become alarmed by peculiar colored markings and scratches which may appear in the reflector surface.

It is important that the quartz arc tube of the burner be kept free of dust, grease and fingerprints. For the first time that the lamp is used and occasionally thereafter *CLEAN* the *BURNER* with Alpine Cleansing Fluid, very pure carbon tetrachloride, very pure alcohol (*NOT RUBBING* alcohol). If these are not available, distilled water may be used. Gently wash the quartz glass with the liquid and wipe dry with a clean cloth.

At other times always dust the burner lightly with a clean soft cloth. Do not finger the burner as finger marks are especially harmful.

PROTECT THE EYES - *WEAR YOUR GOGGLES* - This lamp is a very powerful source for ultraviolet radiations, and each person near the same must have the eyes protected to prevent a burn of the conjunctiva. Even a slight burn of this part is very uncomfortable. Two pairs of goggles are supplied with each lamp. Additional goggles may be procured from depots. The glasses used in these goggles will protect the eyes completely from all ultraviolet radiations and will also lessen the glare from the visible light rays.

If desired, the shutters on the hood of the lamp may be closed during the lighting and warming up period.

TO LIGHT THE LAMP - Snap the switch (8) to the "ON" position. Observe the bluish glow which fills the quartz burner tube. The lamp has started. If the glow is not observed, twirl the starting switch (9) which starts ionization of the starting gas in the burner.

After the lamp has started, several minutes must elapse before full operating intensity has been attained. The arc in the burner tube will then appear as a very brilliant narrow cord of light. The lamp is now ready for use.

TO EXTINGUISH AND TO RELIGHT THE LAMP - Snap the switch (8) to the "OFF" position to extinguish the lamp.

Do *NOT* try to relight the lamp immediately after it has been extinguished. The burner must cool to a temperature at which the discharge can be reestablished. This requires usually a wait of about 5 minutes.

If the lamp is to be employed for a number of successive applications, it is recommended that the lamp be continued in operation instead of being turned off after each treatment.

IF THE LAMP GOES OUT IMMEDIATELY AFTER LIGHTING - If immediately after lighting, the lamp extinguishes itself, it is likely that a fuse in the supply circuit of the building has blown. While lamps normally when started take only the current specified under *ELECTRICAL CHARACTERISTICS*, for a second or two after lighting they may take a few additional amperes of current. If the fuse is not as specified, or if the circuit is overloaded by other equipment, fuses may blow. Check the fuses and other electrical equipment when this occurs.

LAMP MANIPULATIONS

ROTARY ADJUSTMENT OF HOOD - Handwheels (10 and 12) secure the position of the hood. The hood may be swiveled about the horizontal axis through an arc of 90 degrees after the handwheel (10) located on the side of the hood has been loosened. The hood may be rotated through 360 degrees about the vertical axis after the handwheel (12) located on the top of the cross arm has been loosened.

VERTICAL ADJUSTMENT OF HOOD - Vertical adjustment of the hood is accomplished with the assistance of the counterbalance in the upright. To make the adjustment, loosen the locking screw (11) located in the back of the carriage (4). Tighten the locking screw again after adjustment to the new position.

HORIZONTAL ADJUSTMENT OF HOOD - Horizontal adjustment of the hood is accomplished with the aid of the ball-bearing track incorporated in the carriage (4). To make the adjustment, loosen the locking screw (5) located on the side of the carriage, and slide the hood in or out to the new position. Tighten the locking screw to secure in position.

MEASUREMENT OF TREATMENT DISTANCE - The intensity of ultraviolet radiation received upon a surface varies approximately inversely as the square of the distance between the burner and the surface. Since this distance is an important factor in irradiation technic, a tape measure has been provided upon the side of the hood.

RADIATION INTENSITY - At a distance of *three meters* from the burner the ultraviolet radiant energy in the spectral range 2300 to 4000 Angstroms is 500 microwatts per sq. cm.

INSTRUCTIONS FOR REPLACING THE BURNER - *CAUTION:* Check that the electric power is *OFF*.

TO REMOVE BURNER (See Illustration)

1. REMOVE THE TERMINAL COVERS - These are two polished metal covers (20) located one at each end of the burner. They cover the burner terminals, the beaded flexible lead wires, and the terminal jacks (22). Grasp the cover (20) by the hand with the fingers well back towards the reflector. Squeeze the fingers together, and pulling towards you, slip the cover off the flange upon which it normally rests.

2. REMOVE THE LEAD WIRES FROM THE TERMINAL JACKS - Grasp the beaded lead wire with one hand and hold firmly to avoid strain on the burner. With the other hand, gently pull the lead wire towards you until the terminal pin (21) on the end of the wire slips out of the terminal jack (22).

3. REMOVE THE FURNER FROM THE BURNER SUPPORTS - Grasp the burner by the right hand. With the left hand, push the lefthand burner support (24) to the left and hold. Pull the burner gently from its supports.

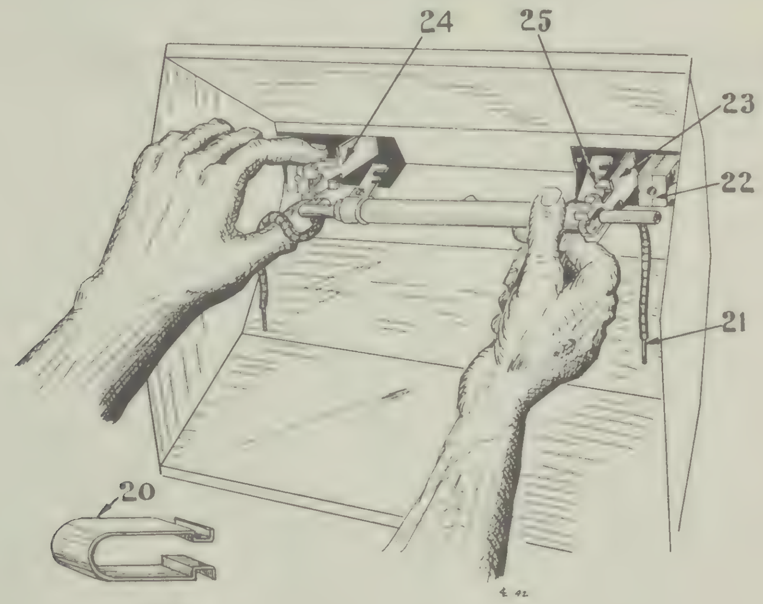
TO INSTALL THE BURNER

1a. PLACE THE BURNER IN THE BURNER SUPPORTS - Grasp the burner with the right hand in a position such that the filling seal and the slotted metal fittings are on the side towards the lamp. With the left hand, push and hold to the left the lefthand burner support (24). Insert the right end of the burner into the righthand burner support (23), taking care that the right slotted metal burner fitting engages the Y-shaped guide (25). Fit the lefthand burner support (24) over the left end of the burner. Release the support and then the burner.

2a. INSERT THE TERMINAL PINS - Insert the terminal pins (21) at end of beaded lead wires into the respective terminal jacks (22).

3a. REPLACE THE TERMINAL COVERS (20) - Grasp the cover with the hand, the fingers being near the flanged edges. Slip the cover over the terminals (22) and the beaded leads. Squeeze the flanged edges of the cover together with the fingers and insert the cover flanges into the opening in the lamp reflector. Release the fingers so that the flanges engage with the reflector.

4a. CLEAN THE BURNER - Clean it very thoroughly before lighting the lamp.



CHAPTER I

ELECTRO MEDICAL EQUIPMENT

SECTION 6

INFRA RED GENERATORS

OPERATION AND USE OF INFRA-RED LAMPS

1. Be sure that the generator is screwed firmly but not forcibly into the socket of the lamp.

The lamp will operate most effectively on 110 to 120 volt current, either A.C. or D.C.

2. With switch on the "OFF" position, plug lamp into an outlet carrying 110-120 volt A.C. or C.D. current, with wiring of ample size to carry current necessary for lamp without overloading the wiring circuit. If there is any question as to your current supply, check it.

3. TO OPERATE the lamp, throw on switch. The generator will reach proper temperature is about three minutes, then showing a cherry red color. The lamp will operate in any position.

IF THE LAMP DOES NOT OPERATE:

1. Check current supply - 110-120 volt.

2. House wiring - check with light bulb in outlet used for lamp.

3. See that infra-red generator is firmly screwed into socket in reflector of lamp.

4. See that lamp attachment plug makes proper contact in receptacle.

USE OF THE LAMP - For most effective use, uncover the part of the body to be treated.

Under normal conditions, the lamp may be placed at such distance that a comfortable sensation of heat is produced in the part treated. At no time during application of the lamp, should there be burning or sensation of discomfort. The patient must promptly report any discomfort and the lamp be removed to a comfortable distance.

When the person receiving treatment is asleep in a coma, delirious, paralyzed, or for any other reason, is not normally sensitive to heat, great care must be taken not to apply the lamp too close. The same applies to children too young to express their reactions to heat. If the lamp is used too close a burn will result.

Usually, applications at proper distance may be made for one-half to one hour, and may be repeated several times a day if indicated.

CAUTION - A survey of accepted medical literature indicates that treatment of certain pathological conditions with infra-red radiation may be harmful.

In those conditions in which treatment is not contra-indicated the physician will consider the type and extent of pathology present, and make such modifications of treatment as may be indicated.

Treatment may be contra-indicated in the following conditions:

Abnormal skin sensation, particularly, anesthetic areas.
Areas of cicatrical tissue.
Febrile or other conditions where overheating may occur.

THESE LAMPS WILL PRODUCE BURNS if used too close. At no time should a lamp be used so close as to cause discomfort or a burning sensation. Use special care over areas insensitive to heat and over scar tissue.

CHAPTER II

STERILIZERS

SECTION I

STEPS IN THE DEVELOPMENT OF STERILIZATION

STEPS IN THE DEVELOPMENT OF STERILIZATION AND MODERN SURGERY

STERILIZATION - Sterilization is the process by which all micro-organisms both disease producing and non-disease producing are killed. It is one of the most important developments that has taken place in surgery. For a surgical operation to be entirely successful, a sterile condition should be maintained throughout the operation and until the patient is well and discharged. It is largely the duty of the nurses connected with the surgery of the hospital to take care of this process. It is indeed a grave responsibility. The surgical nurses must feel the responsibility that the life or death of the patient is in their hands as well as in the hands of the surgeon. The slightest carelessness on their part or on the part of anyone who has to do with the preparation or handling of sterile surgical supplies may endanger the life of the patient and render the highest operative skill of little avail. Under modern conditions the patient goes to the hospital in complete confidence that all possible care will be taken to see that the requirements of aseptic surgery are maintained. The failure to provide these conditions is not only breaking faith with the patient and destroying his confidence in the hospital, but it endangers human life and is a direct cause of death. The principles underlying the processes of sterilization are well known, and before we take up the discussion of them it is well to review briefly the factors which were instrumental in their discovery and development.

THE MICROSCOPE - The first outstanding factor that contributed to the development of the germ theory and the principles of sterilization, was the discovery of the microscope. Robert Hooke constructed the first effective microscope in 1665, but it was not until several years later that its use was applied to the problem in which we are interested. In 1683 the Dutch merchant, Antony van Leeuwenhoek, who spent his leisure time in grinding spectacle lenses, placed some of his lenses in a metal tube and made one of the first compound microscopes. This instrument enlarged objects placed under it about one hundred and fifty times. He examined with this microscope the water from the nearby ponds and swamps, the scrapings taken from the spaces between his teeth and many other fluid and semi-fluid substances. In all of these he found very minute organisms, some of which moved quite rapidly. These organisms he called animalcules and without doubt many of them were bacteria with which we are so familiar today. The nature and importance of these organisms were unknown, and, at the time, very little came from the new discovery. It did, however, open the way for the next step in the development.

SPONTANEOUS GENERATION - Another contributing factor to the development of the germ theory was the results obtained from the experiments and the heated discussions that were waged by the thoughtful and speculative philosophers of the day over the origin of life on the earth. The most generally accepted theory of the origin of life was that of spontaneous generation. The disciples of this doctrine believed that animal life sprang into existence from matter that was not living. For example, it was believed by this school of wise men that if a dirty shirt was pressed into the opening of a vessel containing some corn and bits of cheese, the ferment proceeding from the dirty shirt modified by the odor of the corn and cheese changed the corn and cheese into a thriving family of mice in the course of a few days; or it was believed that if meat was exposed for a limited period of time it was sure to generate a mass of squirming maggots. A few thoughtful observers, however, did not believe in this theory of the origin of life on the earth. Redi, the Italian naturalist, affirmed that the maggots were not spontaneously generated, but that they were hatched from the eggs of flies. He proved his contention by tying a piece of gauze or fine screen over the mouth of the jar containing decaying meat, and thus prevented the development of the maggots in the meat. Since flies could not alight on the meat so protected, no eggs could be deposited and no maggots hatched. When the mother blow fly was actually seen in the act of laying her eggs on the surface of the gauze, and the maggots appeared when the eggs hatched, think-

ing, open-minded men were convinced that maggots, mice and other forms of life came into existence from a pre-existing life of the same kind. Such experiments and observations of a very simple kind soon weakened the general belief in the doctrine of spontaneous generation so far as the origin of the larger forms of life were concerned.

CONTRIBUTIONS OF SPALLANZANI AND SCHWANN - Leeuwenhoek's microscope gave new hope to the spontaneous generationists, when it revealed the existence of a new world teeming with millions of invisible micro-organisms. Redi's experiments made them admit that the larger forms of life were produced by parents, but they still contended that Leeuwenhoek's minute animalcules arose by spontaneous generation and in turn they gave birth to the larger organisms. It was a common observation that beef tea rapidly became cloudy and ill smelling when it was placed in air tight flasks. The microscope revealed that this beclouded broth was swarming with millions of microbes. How did these organisms enter the broth? Did the broth itself generate the micro-organisms, or were there present in it the germs, or the eggs of a pre-existing life of the same kind?

Spallanzani, an Italian priest, answered the question. He demonstrated that, if broth teeming with the micro-organisms were boiled for a few minutes, all of them were killed, and if the flask containing the boiled broth were then sealed air tight, the broth became clear and no living thing could be found in it even after it had been kept for days. However, when air was admitted to the flask, a decomposition took place, the broth became cloudy and foul and micro-organisms were again found living in it. Evidently, then, the air and not the broth carried the eggs or germs of the micro-organisms and again brought them in contact with the broth when the flask was opened.

In 1837 Theodore Schwann confirmed Spallanzani's conclusions. After the broth was boiled, air was allowed to enter the flask only through a tube-like horizontal neck which he kept heated with a flame. The heated tube prevented any living particle in the air from entering the flask when it cooled. So long as heated air entered the flask, the broth was kept sweet and fresh, but when unheated air entered it, the broth became cloudy and swarmed with thousands of micro-organisms. Filtering the air through a cotton plug produced the same effect as the heated air. The cotton filter allowed the air to enter but strained out the thing which caused the decomposition. This proved that the air was simply the vehicle that carried the contaminating influence. For the first time Schwann advanced the theory that fermentation was caused not by the gasses in the air, but by living organisms which were suspended on the dust particles in the air. This doctrine received very little attention at the time. It took the work of Louis Pasteur, the great French scientist, to make it an assured and accepted fact.

PASTEUR DISCOVERS BACTERIAL CAUSE OF FERMENTATION - Pasteur became interested in the problems of fermentation about 1860. His experiments and researches proved conclusively that fermentation was caused by the activity of micro-organisms carried on the dust particles in the air, and not caused by the gases of the air. He readily saw the similarity between the putrefactive changes which took place in the human body and the processes of fermentation which he had just discovered; and he soon proved that putrefaction and decomposition were also caused by the activity of a micro-organism. This experiment which clearly demonstrated the definite relation between the activity of germ life and decomposition was Pasteur's first great contribution to the field of work in which we are interested. This was followed by his solving the mysteries of some of the destructive diseases which afflicted man, and finally led to his discovery of means by which humanity can protect itself against the destructive activities of the harmful micro-organisms causing the dis-

ease and against their poisons when once they are introduced into the human system.

LISTER'S DISCOVERIES - The first practical application of Pasteur's wonderful discovery to the field of surgery was made by Joseph Lister, an eminent English surgeon. Prior to the time of Pasteur and Lister, the conditions existing in the hospitals were appalling. All open wounds, both accidental and surgical, became infected. In many instances this condition was followed by such diseases as erysipelas, lockjaw, gangrene and blood poisoning. Contagion was most common and the death rate was very high. Lister was alarmed over the serious situation which he encountered in his own hospital and made a determined effort to better the terrible conditions. He repeated Pasteur's experiments on fermentation and putrefaction and became convinced that microbes suspended on the dust particles in the air were the cause of the decomposition and disease in wounds and were directly responsible for the frightful conditions and high death rate existing in his own institution. Lister clearly states the conclusions drawn from Pasteur's experiments in his original paper published in the Lancet, 1867. He says:

> "Turning now to the question of how the atmosphere produces decomposition of organic substances, we find that a flood of light has been thrown upon this important subject by the philosophic research of M. Pasteur, who has demonstrated by thoroughly convincing evidence that it is not to its oxygen or to any of its gaseous constituents that the air owes this property, but to minute particles suspended in it, which are the germs of various low forms of life, long since revealed by the microscope, and regarded as merely accidental concomitants of putrescence, but now shown by Pasteur to be its essential cause, resolving the complex organic compounds into substances of simpler chemical composition, just as the yeast plant converts sugar into alcohol and carbonic acid."

Fortified with the knowledge secured from the study of these experiments, he decided to apply it in the treatment of wounds that came under his care. He began by using carbolic acid in the treatment of compound fractures. At that time, two out of every three patients with compound fractures died. The marked success which Lister had in dressing compound fractures with carbolic acid, caused him to use it in treating abscesses. Further success in this field led him to try the treatment in accidental wounds and finally to extend its use to extensive surgical operations. As Dr. Osler says, "From these beginnings modern surgery took its rise, and the whole subject of wound infection, not only in its relation to surgical disease, but to child's bed fever, forms now one of the most brilliant chapters in the history of Preventive Medicine."

ANTISEPTIC SURGERY - The outstanding successes of Lister's experiments firmly established antiseptic surgery; and a diligent search was instituted to discover those drugs, such as phenol, mercuric chloride, boric acid, formaldehyde, iodoform, etc., which would destroy or arrest the activity of the troublesome micro-organisms that infected wounds. As these antiseptics and the antiseptic processes entered one door of the hospital, the dreaded scourges of septic surgery, - erysipelas, lockjaw, gangrene, blood poisoning, and high death rate--hastily retreated through the other door. The splendid work of Pasteur and Lister had transformed the hospitals from places of dread to institutions of safety and relief.

RESULTS OF THE ANTISEPTIC PROCESSES - The processes of antiseptic surgery did two important things to pave the way for the new surgery which followed. First, they proved conclusively that sepsis and suppuration are caused by micro-organisms and second, that certain micro-organisms are definitely responsible for certain of the dreaded diseases which were the nightmare of the surgeons of the septic days. These facts established, naturally the question was asked, why not destroy the harmful invading microbes before they have the opportunity to enter the wound and especially so in the case of surgical operations; that is, start with a clean field of operation, maintain a clean field during the operation, close the operation with a clean field and keep it clean until the wound is healed and the patient discharged. Through the untiring efforts and cooperation of men both in the surgical and technical fields, the result has been accomplished largely through the agency of sterilization. And so effectively has sterilization done its work, that today it is the essence of our modern day aseptic or clean surgery, just as the antiseptics were the essence of Lister's surgery.

CHAPTER II
STERILIZERS

SECTION 2
BACTERIOLOGY

The process known as Sterilization concerns the destruction of harmful or pathogenic bacteria. In order to accomplish this in an efficient and positive manner, certain pieces of equipment have been designed for this purpose. It is this equipment that the student will learn to service as the class progresses. First of all, however, it would seem proper that the student have some fundamental knowledge of the micro-organisms which we seek to destroy by sterilization.

In the first place, it should be thoroughly understood that all goods and instruments used during an operation be absolutely sterile; in fact, an operation would have but little chance of achieving a successful outcome, were this not the case. Because of this, one can readily understand the vital importance of the sterilizing equipment and the fact that it should always be maintained in tip-top condition.

WHAT MICRO-ORGANISMS ARE CALLED - That we may better understand the processes of sterilization and the fundamental scientific principles that guide the manufacturer in the construction of efficient sterilizing equipment, it is advisable to review some important facts about micro-organisms which are often referred to as bacteria, microbes or germs, and are sometimes erroneously called bugs. The following facts should be remembered.

WHAT BACTERIA ARE - Bacteria do not belong to the animal kingdom, and are not bugs. They are plants, and represent the simplest form of vegetable life. In size, they are the smallest of all living things, being entirely too small to be seen with the unaided eye. Under a powerful microscope, they appear to be very small colorless sacs that are filled with a clear substance. They differ from the plants so commonly seen in nature in that they do not possess any green coloring matter, and further, in the fact that all the vital functions necessary for their existence, such as nutrition, growth and reproduction, are carried on in a single, simple, sexless cell.

WORK OF BACTERIA - Bacteria are found everywhere in nature and play an important part, both for good and bad, in the cycle of life on the earth. They have succeeded in meeting the constant change in conditions since the beginning of life on the earth, and in adapting themselves to each new environment to carry on their never ending activity. It would be impossible for life to exist on the earth, if it were not for the important work of the microbe. Thousands of varieties of bacterial life are the best friends that man has, and not his worst enemies as is commonly supposed. They break up the refuse and waste of the world into the elements of which they are made, and return them to nature in their simple forms to be used over and over again for the perpetuation and welfare of life on the earth.

SIZE OF BACTERIA - In size bacteria are the smallest of all living things. It requires a microscope of very high power to make the individual microbe visible to the human eye. The microbe that causes typhoid fever is approximately 1/12000 of an inch long and about 1/25000 of an inch in diameter. Although this may seem very small, yet this microbe is eight times larger than the Bacillus Influenzae. This microbe is so small that it takes more than one hundred twenty million millions of them or 120,000,000,000,000 to weigh one ounce.

MOVEMENTS OF BACTERIA - Many bacteria possess the power of moving through the fluid in which they live. The motion is produced by very delicate hair-like outgrowths from the body of the microbe. These outgrowths are called flagella, each being from one to twenty times as long as the organism itself. Each motile bacterium may have one or more flagella, located either at one or both ends, or, in some cases, on all sides of the cell. The vibration of these flagella act somewhat like

the oars of a boat, and propel the microbe through the liquid in which it is suspended. By this means, a bacterium can travel about four inches in one hour. This is indeed a rapid rate. If a man should travel at the same rate in proportion to his size, he would be going more than one mile per minute.

REPRODUCTION OF BACTERIA - When a bacterium is placed in a favorable environment of temperature, moisture and food, it becomes somewhat longer than its normal length, and a slight constriction begins to appear at a point half way between the ends of the cell. This constriction becomes deeper and deeper until finally the parent cell is divided into two equal cells similar in all respects. Both cells grow rapidly to maturity. Each of the resulting cells then divides in the same way, and succeeding cells continue to do so as long as favorable living conditions exist. Under the most favorable conditions, a new generation of bacteria of the more rapidly growing species will be developed every fifteen minutes. Evidently then, bacteria multiply most rapidly. At this rate one microbe can theoretically increase in twenty-four hours to 78,700,000,000,000,000,000,000,000,000, a number far beyond our comprehension. Nature has, fortunately for man, provided obstacles that prevent such an enormous development and that keep the growth of bacteria within limits that can be endured. Even then, it is evident, that if only one harmful bacterium should escape the destructive processes of sterilization, within less than one day, it could produce, under favorable conditions, a hostile invading army of countless millions ready to enter not only the natural openings of the body, but also to enter every breach made in the protective armour of man--the skin--and cause untold suffering and misery.

COMPOSITION OF BACTERIA - Bacteria, like animals and other plants, are made up of about eighty-five per cent water. The water in the bacterium is held in a jelly-like mass called protoplasm. This protoplasm, which constitutes the other fifteen per cent of its body, is that mysterious, life producing, life maintaining substance, which is the basis of all forms of life. If the protoplasm is coagulated or solidified, the microbe will die. The water which it contains is just as necessary for its existence, for if it is withdrawn in part or in whole by the ordinary methods of drying, either the activities of the microbe will be arrested, or the life of the cell will be destroyed. This gives us the means by which the vital activities of the troublesome micro-organisms can be controlled.

CLASSIFICATION OF BACTERIA - Bacteria are divided into three general groups or classes on the basis of their form and structure. One group is spherical in shape and resembles a very small berry. In fact, it gets its name coccus from a Greek word meaning berry. The second group includes all bacteria which are shaped like a rod. They are called bacilli which is derived from a Latin word that means stick. The third group is stretched out and long like the bacilli with the addition of being curved like a corkscrew. Their name is spirilla which indicates they are shaped like a coil.

For our purpose, all bacteria may be further divided into two groups, the pathogenic and the non-pathogenic. The non-pathogenic are those bacteria which do not produce disease. The pathogenic bacteria are those which cause disease. They possess the ability to penetrate and escape from the tissues of its victims, and in that way to cause and transmit disease peculiar to themselves from one person to another. It is this group of micro-organisms that has given to all bacteria the bad reputation they have, and is the group in which we are particularly interested.

NON-SPORE-FORMING PATHOGENIC BACTERIA - Bacteria are further classified into groups called spore formers and non-spore formers. All pathogenic bacteria, as a rule, exist in the vegetative state. It is in this state that they carry on all the

vital functions such as nutrition, growth and reproduction, so necessary for their existence; and also the state in which they are so active and dangerous. The non-spore bearing bacteria work and exist only in the vegetative form. When they are removed for any length of time from the conditions of temperature, moisture and food favorable for their existence, they die. Such characteristics make it possible to gain control over this type of bacteria.

SPORE-BEARING PATHOGENIC BACTERIA - There are a few pathogenic bacteria that possess the power to form spores. Spore formers exist in both states, but are most active and harmful when in the vegetative state. When a spore former is exposed for any length of time to unfavorable living conditions, it has within its cell, the power to protect itself by changing its form. The water content of its body decreases to a minimum, its protoplasmic mass becomes more condensed and concentrated until the entire cell assumes a cloudy appearance to be changed in a short time to a shining mass enveloped by a dense membrane or covering. This is the spore or "seed" of the vegetative form. It is the resting state of the cell, and the microbe will continue to hibernate or sleep in this state for an indefinite period of time, or until it is again placed in an environment that is favorable for its growth and development. Only one spore forms in a single organism, and only one organism comes from the spore when the "lean years" are over. The spore may be found located at the center of the cell, or the end, or at some point between the center and the end of the cell. The size and location of the spore in the cell is an aid in identifying the spore former with which you have to deal. Some spore formers are shaped like a wedge, the B. butyricus forms its spore at the center of the cell and is spindle shaped, while the tetanus or "lockjaw" germ has its spore at the end and looks very much like a drumstick.

RESISTING POWERS OF SPORES - In the spore state the resistance of the microbe is greatly increased against the action of the agents, both physical and chemical, that are used for its destruction, as well as against any unfavorable environment in which it may be placed. Its resisting powers are demonstrated by the fact that some spores can be kept at the temperature of boiling water for several hours without being destroyed. Others have been dried for a number of years and were not killed. For example, about forty years ago a distinguished bacteriologist dried on threads some spores derived from a culture of anthrax bacilli. He placed the threads in air tight sealed glass tubes. After a period of thirty-five years, it was found that only one-eighth of an inch of this infected thread contained a sufficient number of virile organisms to cause the death of mice when only one drop of the bouillon, which contained the growth of bacteria produced from the spores was injected under the skin of a mouse at the base of its tail. Evidently, the drying for thirty-five years had not killed the spores of the anthrax bacilli, neither had it prevented their development into active organisms when placed in favorable surroundings, nor diminished the virulence or deadliness of their descendents to a point where mice could resist an infection from even one drop of a culture made from the spores.

CONTROL OF PATHOGENIC BACTERIA - Man is indeed fortunate in that the bacteria which cause the epidemic diseases, such as typhoid, pheumonia, scarlet fever, etc., do not form highly resisting spores as a part of their life history. Most of the pathogenic bacteria do not form spores at all as a means of prolonging their life when they are removed from favorable living conditions. Because of this, the control of infections following an operation becomes quite simple by destroying the bacteria that cause them through the application of those agents, such as heat and the various antiseptics, which will kill bacteria. It is also clear, that the spore forming bacteria are the ones in which modern surgery should be interested from the standpoint of sterilization. Any agent, either physical or chemical, which will destroy this type of bacteria, will be more than sufficient to destroy all forms of disease producing micro-organisms.

CHAPTER II

STERILIZERS

SECTION 3

PRINCIPLES OF STERILIZATION

PRINCIPLES OF STERILIZATION

OBJECT OF STERILIZATION - A most important concern and work of the nurses connected with the surgery of a modern hospital is to prepare dressings and other surgical materials that are aseptically clean for use in the operating rooms. This is accomplished by the processes of sterilization. The object of sterilization is to kill bacteria of all kinds, and particularly the bacteria which have the power of producing infection and disease. A bacterium can be killed either by reducing the water in it to a point where all of its vital processes are stopped, or by coagulating or solidifying its protoplasmic mass. Heat in its various forms is generally used in the process of sterilization for accomplishing both of these results, but sometimes, and in some cases, chemicals or antiseptics are used for destroying the harmful micro-organisms.

STERILIZATION BY CHEMICAL AGENTS - Chemicals or antiseptics were the first agents used for destroying bacteria, which infected wounds and caused infections. They were the principal means for securing sterile conditions in *antiseptic surgery*, and proved so effective that they have been called the essence of this type of surgery. The effectiveness of these agents depends upon the antiseptics used. In many cases they do not insure a complete sterilization, but merely produce a partial or temporary arrest of the activity of the invading microbes. Where very strong antiseptics or germicides are used to secure a true sterilization, a serious difficulty generally arises. Such antiseptics generally prove to be a source of irritation to the tissues damaged in the operation, and delay the healing of the wound. Although this has led to the development of other processes for securing sterile conditions that are less harmful to the tissues, yet antiseptics continue to play an important part in securing aseptic conditions in the modern operating room. However, aseptic or modern surgery, with its strong emphasis on prevention, requires sterilization by heat whenever it is possible.

HEAT STERILIZATION - The most widely applicable and efficient physical agent for sterilization is heat. Man has used heat as a sterilizing agent for hundreds of years. It was an ancient custom to pass knives and other metal objects through a flame to cleanse and purify them. Dry heat, in the form of hot air, was the agent employed by primitive man for drying food when there was a great abundance and thus preserving it until a time when it became scarce and difficult to secure from the natural sources of supply. The processes were not even thought of as processes of sterilization, but in reality they were the humble beginnings of our present day processes of heat sterilization. In searching for the best and most practical methods of killing bacteria, it was demonstrated that heat in its various forms was a very effective agent for destroying the harmful micro-organisms which caused infection and disease. Since that time it has been the agent most commonly used, and has been applied in the form of the flame, boiling water, and moist heat or steam with or without pressure.

STERILIZATION BY THE FLAME - The actual flame is the most effective but, due to its destructive properties is probably the least used of all the agents that are known for securing sterilization. Its use is limited practically to the sterilization of platinum wires, needles, cover slips, and other small objects which are used in handling bacteria in the laboratory; and also for the destruction of worthless and infectious materials. The Bunsen flame or the alcohol flame is the chief source of the sterilizing agent.

STERILIZATION BY DRY HEAT - Dry heat sterilization is carried out in a hot air chamber, or an oven. It is in fact sterilization by hot air. This method proves to be very useful for sterilizing when no steam outfit is available. It is constantly used in the laboratory for the sterilization of glassware, etc. provided the heat can reach all parts of the objects to be sterilized. To secure an absolute

sterilization by this process, a temperature of 320° Fahrenheit must be maintained in the sterilizing chamber for at least one hour. The method, however, cannot be recommended for the sterilization of dressings since dry hot air does not penetrate very well, and besides the high temperature that is necessary to secure a sterile condition by it, almost always scorches and damages the cotton materials from which the dressings are made.

STERILIZATION BY MOIST HEAT - Sterilization by moist heat is the method that is now used in the modern hospital for securing the necessary sterile supplies for surgical use. As a sterilizing agent moist heat is more penetrating than dry heat, not so destructive of the materials and substances to be sterilized, and effectively kills disease-producing bacteria in a very much shorter time. It is usually applied in the form of boiling water, freely flowing steam, or steam under a pressure of from 15--20 pounds. With boiling water and freely flowing steam, a temperature of approximately 212° Fahrenheit can be maintained for any desired period of time. Much higher sterilizing temperatures can easily be secured through the agency of high pressure steam -- the degree of heat obtained, of course depending upon the steam pressure employed. Metal and glass instruments, utensils, syringes, tubes and other substances with smooth surfaces may be effectively sterilized by boiling them in water. Frequently rubber gloves are sterilized in the same way. Boiling such articles for a period of ten minutes is amply sufficient to destroy the vegetative forms of bacteria. For the destruction of spores, a higher temperature of moist heat applied for a longer period of time must be employed. Such conditions can only be secured through the use of heat in the form of high pressure steam.

EFFECTS OF MOISTURE ON THE THERMAL DEATH POINT OF BACTERIA - One of the most rapid and effective ways to kill bacteria is to coagulate or solidify their protoplasmic mass through the application of the proper amount of heat and moisture. The temperature at which the protoplasm of the bacteria will coagulate depends upon the amount of moisture present. Lewith, working with proteins, found that these substances are coagulated by heat at lower temperatures when they contain abundant quantities of water, than when water has been taken from them. On the basis of actual experiment with egg albumen, a substance very similar to bacterial protoplasm, the following results were obtained which nicely illustrate the point in question:

> Egg albumen in dilute solutions coagulated at 133° F.
> Egg albumen with 25% water coagulated at 165° 176° F.
> Egg albumen with 18% water coagulated at 176° 194° F.
> Egg albumen with 6% water coagulated at 293° F. Absolutely anhydrous or very dry egg albumen may be heated to 338° F. without coagulating.

It is evident from these figures that when there is an abundance of moisture present, albumen or the protoplasmic mass of bacteria can be coagulated at comparatively low temperatures. This explains why moist heat is such an ideal agent for securing sterile conditions. *Heat and moisture, then, when applied for the proper period of time, are essential elements necessary to destroy bacteria;* and naturally boiling water and moist steam under pressure are the easiest and most convenient ways in which these agents can be applied for this purpose.

THERMAL DEATH POINT OF BACTERIA - The thermal death points of many bacteria

have been carefully studied by Sternberg. The thermal death point found by him for a number of the most common non-spore bearing bacteria when exposed for ten minutes in a fluid medium are as follows:

Spirillum cholerae asiaticae	126° F.
Diplococcus pneumoniae	126° F.
Streptococcus pyogenes	129° F.
Bacillus typhosus	133° F.
Bacillus pyocyanens	133° F.
Bacillus mucosus capsulatus	133° F.
Bacillus prodigiosus	136° F.
Staphylococcus pyogenes aureus	136° F.
Diplococcus gonorrheal	140° F.
Staphylococcus albus	145° F.
Bacillus tuberculosis	158° F.

This means that non-spore bearing bacteria such as those which cause typhoid, pneumonia, tuberculosis, Asiatic cholera, etc., can be destroyed by exposing them for a period of ten minutes in water heated to a temperature ranging from 125° Fahrenheit to 160° Fahrenheit. All vegetative forms--non-spore bearing bacteria--can be destroyed then by boiling them in water, 212° Fahrenheit, for a period of time ranging from ten to twenty minutes. The spore formers, however, require the application of moist heat at much higher temperatures and for longer periods of time to render them inactive and sterile. Any sterilizing device which will effectively destroy all pathogenic spore formers will render sterile all bacteria that cause disease.

STERILIZING TEMPERATURES FOR SPORE FORMERS - What is the optimum temperature and the necessary period of time that is required to effectively destroy the most resistant pathogenic spore formers?

The authoritative observers do not agree on this point. Their conclusions range from 230° Fahrenheit to 248° Fahrenheit, the heat to be applied in the form of moist steam for a period of time ranging from five to twenty five minutes. It is evident then that all would agree that a perfect sterilization will be the result if the disease producing bacteria are subjected to a moist heat of 250° Fahrenheit for at least a period of twenty-five minutes.

HIGH PRESSURE STERILIZER OR AUTOCLAVE - With the above facts established, the manufacturers of sterilizing equipment set themselves the task of constructing equipment which will make possible the conditions required for a complete sterilization. The result is the modern high pressure sterilizer or autoclave. It uses as its sterilizing agent moist steam placed under a pressure of from 15--20 pounds. This insures a moist heat of 250° to 259° Fahrenheit, which are temperatures even higher than that advised by the best authority, applied,in the sterilizing chamber. As an extra precaution, it is strongly urged that the sterilizing period should be at least thirty minutes long, which is five minutes longer than that recommended by the best authorities.

HEAT PENETRATION NECESSARY FOR COMPLETE STERILIZATION - Under certain conditions, however, a moist heat of from 250° Fahrenheit to 259° Fahrenheit may be applied to the dressings for a period of thirty minutes, and even longer, without necessarily insuring a complete sterilization of the dressings. The moist heat must thoroughly penetrate the dressings, otherwise all germ life present will not be destroyed. To insure the proper penetration, it is advisable to consider seriously the way in which the dressings are prepared, *and to see that the air is removed from the sterilizing chamber during the sterilizing period.*

THE PACKAGES OF DRESSINGS - As the demands of the operating room for surgical supplies increase, there is a tendency for the assistants in the sterilizing room to unconsciously and very gradually increase the size of the packages, and wrap them more tightly than they should. The packages must be wrapped loosely. Their size must be moderate, and they should be packed into the sterilizer as loosely as is consistent with the size of the sterilizing chamber. This is absolutely necessary to insure a perfect penetration by the steam. Unless the heat and moisture penetrate to the very center of the dressings, a perfect sterilization will be difficult to secure.

THE EFFECTS OF AIR ON PENETRATION - The air must be removed from the sterilizing chamber before a thorough penetration of the dressings by the steam can be obtained. There is a fundamental property of matter, which is, that no two substances whether they be solids, liquids or gases can occupy the same space at the same time. One must be pushed out of the way before the other can occupy its place. When the packages of dressings are prepared they are completely filled with air. This air must be removed before even steam under pressure can occupy its place, and penetrate to the center of the dressings. Without penetration, there can be no guarantee of sterilization. To remove the air and overcome this difficulty most high pressure sterilizers are equipped with an air and condensation ejector, that automatically removes the air and condensation which forms in the sterilizing chamber during the sterilizing period, and insures a perfect penetration and a complete sterilization.

THE TEMPERATURE IN STERILIZER AFFECTED BY PRESENCE OF AIR - The presence of air in the sterilizing chamber will also affect the maximum temperature obtained in the chamber. It will prevent the temperature from reaching that degree of heat which corresponds to the steam pressure indicated by the pressure gauge on the sterilizer. Dalton's law in physics states that, when air and steam occupy the same vessel, the total pressure in the vessel is equal to the sum of the partial pressures of both the steam and air present, and that the temperature in the vessel will correspond to the partial pressure of the steam only. For example, if the air is not removed from the sterilizing chamber and steam is allowed to enter it until the pressure gauge registers a pressure of eighteen pounds, experiments conducted at the University of Wisconsin have demonstrated conclusively that the eighteen pounds steam pressure is not all steam pressure, but that six pounds of this pressure are due to the air in the chamber, and that only twelve pounds are produced by the steam present. From Dalton's law, the temperature obtained in the sterilizing chamber is determined entirely by the actual steam pressure present. The twelve pounds of steam pressure in this case means that the maximum temperature secured in the sterilizing chamber is 242.5° Fahrenheit instead of 255° Fahrenheit, the temperature that one would expect to obtain from an eighteen pound pressure. The 242.5° Fahrenheit is not a sufficiently high temperature to kill all the resistant spore forming bacteria. Then to obtain the best conditions for the sterilization of surgical dressings, it is necessary to remove all the air from the sterilizing chamber. This is accomplished by the air and condensate discharge.

HOW TO DETERMINE THE PROPER STEAM PENETRATION - There are a number of controls which may be used to determine if the steam has thoroughly penetrated the dressings. The control most generally used is the one manufactured by the Diack Company of Detroit, Michigan. This control is composed of a small pellet of fusible material which is enclosed in a small sealed glass tube. The pellet will melt and change its color at a temperature sufficiently high to kill all the pathogenic spore forming bacteria. These controls should be placed in the center of the largest packages of dressings with which the sterilizing chamber is packed. If the controls are melted when the test packages are opened, at the close of the sterilizing period,

this is a reliable evidence that a sufficient steam penetration has been secured. A bacteriological test of the dressings that have been subjected to the sterilizing process is the most reliable evidence that can be had to determine whether a thorough penetration and a complete sterilization has been obtained.

As an additional safeguard all modern autoclaves are equipped with a thermometer located in the air condensation exhaust line system directly below and in front of the bottom of the chamber. This is the coolest part of the sterilizer, and as long as this thermometer registers the desired sterilizing temperature we may be sure that the contents of the sterilizer chamber, if properly packed, are being subjected to the proper temperature for sterilization.

Fundamentally all goods such as dressings, bandages, sponges, towels, sheets, operating gowns, etc., water and solutions, instruments and utensils may be sterilized in an autoclave. However, for greater convenience and flexibility other sterilizing units are also used to accomplish the sterilization of water, instruments and utensils.

WATER STERILIZERS - There is little difficulty involved in rendering tap water completely sterile. It is obvious that dried and highly resistant spores are not encountered in water and there is no problem, as in sterilizing dry goods, of penetration of dense masses of materials. The gauge of sterilization is the thermometer and it indicates the water temperature directly. We have the accurately measured degree of *heat* and the water itself furnishes the *moisture factor*.

Water may be sterilized either by boiling in an open non-pressure type container or preferably in a specially designed apparatus in which the water may be heated under pressure.

A pressure water sterilizer consists primarily of a pair of tanks, which during the period of sterilization are hermetically sealed automatically, thus permitting the water to be heated under pressure to higher temperature than would be possible in a non-pressure or open container in which the temperature of course, could not exceed 212° F. at sea level (i.e., the boiling point of water at sea level).

The great advantage of a properly designed pressure water sterilizer lies not only in the fact that a higher temperature may be reached than in the non-pressure type, but also that the water once sterilized may be kept sterile in a reservoir of this type, a difficult if not impossible condition to fulfill in a non-pressure or open type water sterilizer.

While, as stated above, a pressure water sterilizer seals itself hermetically during the period of sterilization (to prevent the escape of steam during this process) it will also be understood that a system must be provided to permit the escape of air from the tanks when they are being filled with water prior to sterilization and also to permit air to enter the tank as the water cools after sterilization, and air too must also replace the sterile water when this is withdrawn from the sterilizer.

The various manufacturers of this equipment provide devices of different design to accomplish the above two purposes. It is also important to note that some means of filtering the dust borne bacteria from the air admitted to the tanks, must be incorporated in these devices. Without an efficient means of filtering this air, bacteria would be brought into the tanks and recontaminate the contents.

The minimum temperature and time requirements for the sterilization of water

are as follows:

250° F. for one minute
240° F. for four minutes
230° F. for ten minutes

As in the sterilization of dry goods it is appropriate to establish the sterilizing temperature range at 240° F. minimum to 250° -- 256° F. maximum, timing the exposure when the thermometer indicates 240° F. Since there are no variables with respect to the character of the load, as in dry goods sterilization, it is perfectly practical and safe to establish the sterilization period at 10 minutes at the above mentioned range in temperature.

INSTRUMENT AND UTENSIL STERILIZATION BY THE BOILING METHOD - It is now generally conceded that the best technique calls for the sterilization of instruments and utensils in an autoclave. However under certain circumstances such equipment may either be unavailable or inconvenient to use, in which case sterilization is obtained by the boiling method. That is, the instruments or utensils are submerged in boiling water for a specific length of time. The sterilizers used for this purpose are known as non-pressure instrument, and utensil sterilizers, respectively.

The prime requisites in using this type sterilizer are as follows: First of all the instruments and utensils to be sterilized should be thoroughly washed, taking particular care that all pus and blood be cleaned from the joints and crevices; secondly, it is of the utmost importance that the items to be sterilized be completely submerged in the water; thirdly, adequate time should be allowed for sterilization (at least twenty minutes), from the time the water reaches boiling point until the instruments and utensils are taken out. Fortunately the difficult spore bearers are very rarely encountered in the surgery. This in addition to the fact that the instruments and utensils are submerged in water (moisture factor) and offer only plane surfaces for contact with the sterilizing medium, they thus involve no problem of penetration as do bandages, gauze, etc., and enable one to obtain satisfactory sterilization of instruments and utensils by this method.

It is claimed by recognized authorities that a 1% sodium carbonate solution distinctly hastens the destruction of bacteria and spores, and for all instrument utensil sterilization this is recommended.

	ITEMS	CONDITION	TIME in minutes	TEMP. °Fahrenheit	PRESSURE lbs.of steam
AUTOCLAVE	DRESSINGS	wrapped* or lightly loaded drums	30	259	20
		fully loaded drums, double liners	45	259	20
	UTENSILS	single, wrapped*	10	250	15
		utensils nested, wrapped*	15	250	15
	INSTRUMENTS	wrapped*	15	250	15
	RUBBER GLOVES	in double muslin wrappers	15	250	15
	SOLUTIONS	1000 cc flasks	20	250	15
		2-3000 cc flasks	25	250	15
PRESSURE	WATER		20	250	15
NON-PRESSURE	INSTRUMENTS		20	212	
	UTENSILS	normal load	20	212	
		if heavy and nested	30	212	
	WATER		30	212	
HOT AIR	VASELINE	not more than 4 ounce containers	120	320	
	BONE WAX	unsterile, in very small portions	60	320	
	VARIOUS OILS		60	320	
	TALCUM POWDER	in bulk	120	320	

The above time and temperature table is not to be considered a criterion to be adhered to without deviation, nor is it to be considered a final authority as to the time and temperatures to which the various items to be sterilized should be exposed. It has been compiled from data issued by the several manufacturers of sterilizing equipment which in turn are based on the highest bacteriological authorities. However, since there are some minor variation in the time and temperatures recommended, it has been thought advisable to compile this table, which represents a safe average for the use of lay personnel.

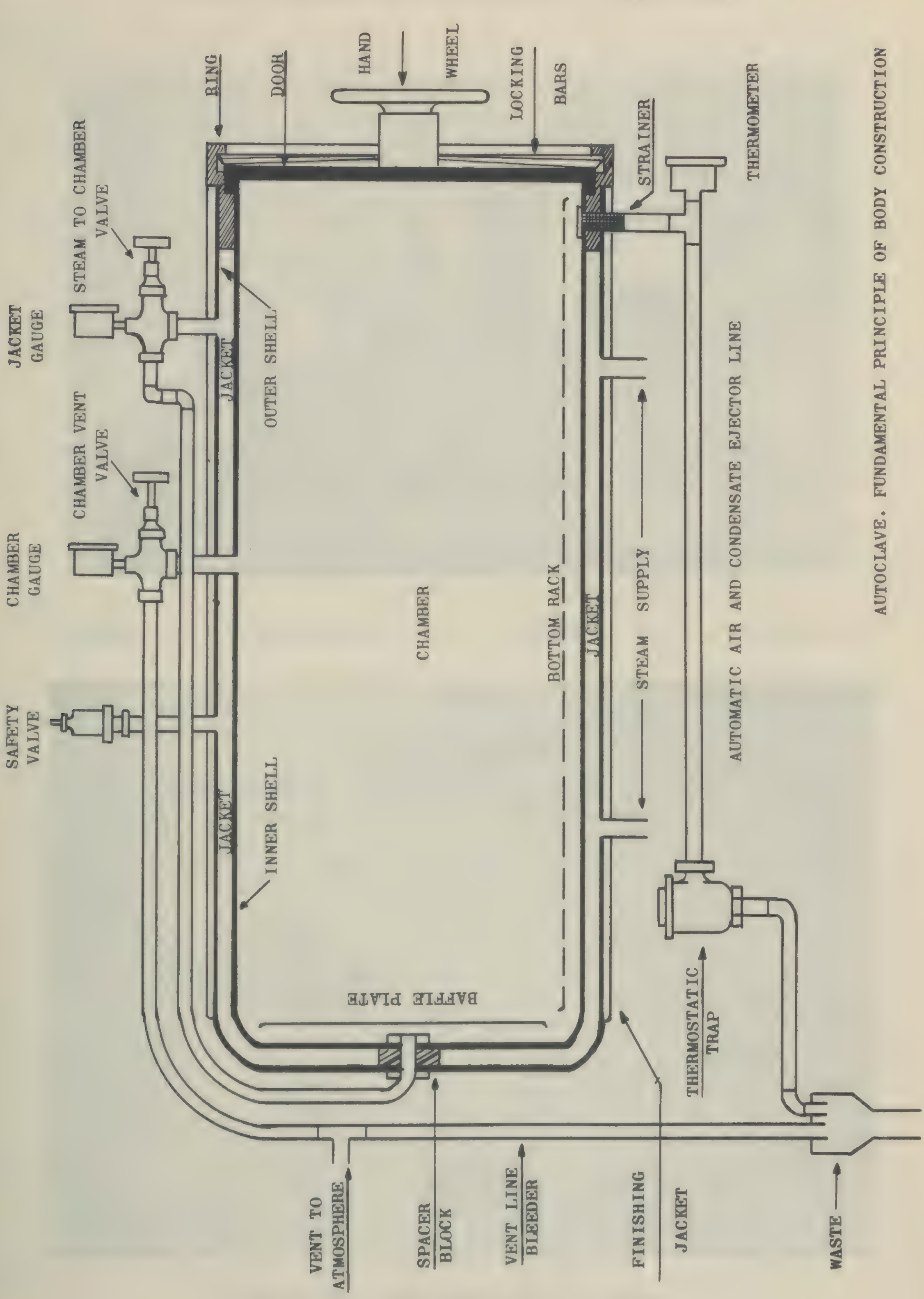
* wrapped indicates double muslin covers

CHAPTER II

STERILIZERS

SECTION 4

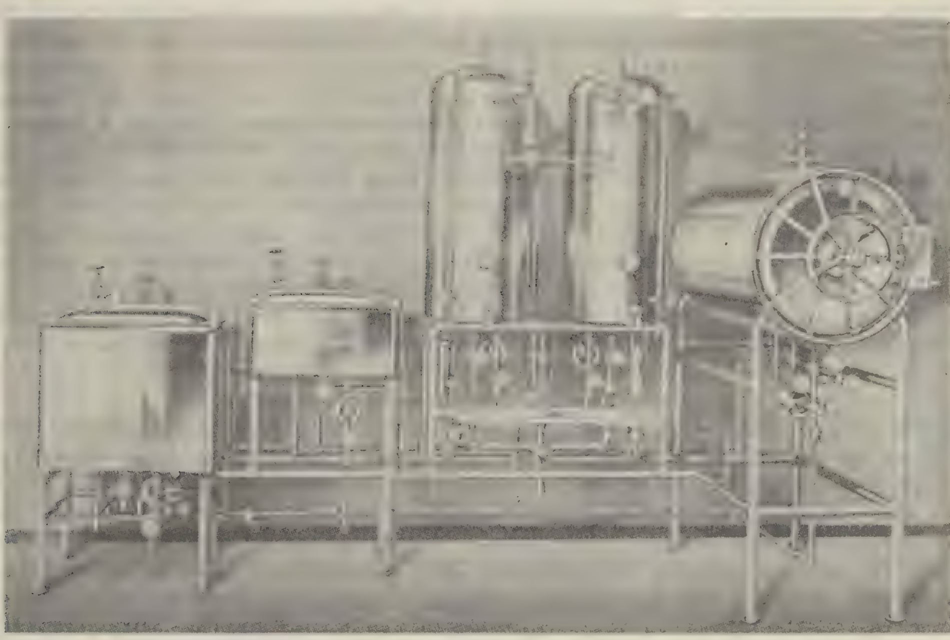
TYPES AND KINDS OF STERILIZERS



AUTOCLAVE. FUNDAMENTAL PRINCIPLE OF BODY CONSTRUCTION

TYPES AND KINDS OF STERILIZERS

TYPICAL BATTERY OF STERILIZER: STEAM HEAT



UTENSIL INSTRUMENT WATER AUTOCLAVE

STERILIZERS RECESSED IN TILE WALL

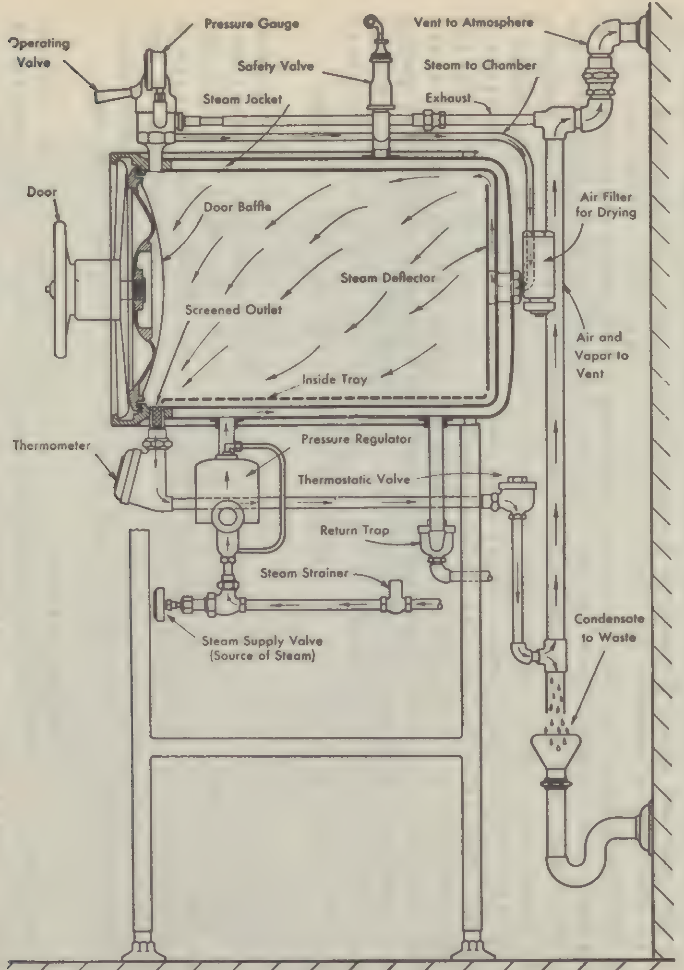
KINDS OF STERILIZERS - Sterilizers are provided for each general class of material to be sterilized. The autoclave or high pressure dressing sterilizer is used for sterilizing dressings, gowns, and similar materials; a set of water tanks is provided for the sterilization of water; there is a sterilizer for producing sterile surgical instruments; and a utensil sterilizer for the sterilization of pitchers and basins. Each of these sterilizers can be supplied as a single unit mounted on either an individual stand or wall brackets. It is common practice to supply the various sterilizing units in battery form for the main sterilizing rooms. An exposed battery of sterilizers is usually composed of a high pressure dressing sterilizer, a set of high pressure water sterilizers, a non-pressure instrument sterilizer and a non-pressure utensil sterilizer, which are mounted in combination on one tubular steel stand or on wall brackets. Batteries of sterilizers, however, are made of two, or for that matter, any number of sterilizing units that will best suit the requirements of the hospital and the space that is available for their installation.

RECESSED STERILIZERS -The latest and most modern installation for sterilizers is to recess them in one of the walls of the sterilizing room. In such an installation, only the sterilizer door and door collar, the steam pressure gauges, and the operating valves are exposed. The piping and body of the sterilizers are hidden in a closet room adjoining the nurses' work room. The recessed installation affords many advantages. In appearance, it is very neat and attractive. The efficiency of the sterilizing room is increased as it provides more space in which to work. The heat in this room, due to the sterilizers, is greatly diminished, and the work necessary to keep the exposed nickel plated parts clean and bright is reduced to a minimum. If the sterilizers are in need of adjustment or repairs, such service can be given without interfering in any way with the nurses working in the sterilizing room.

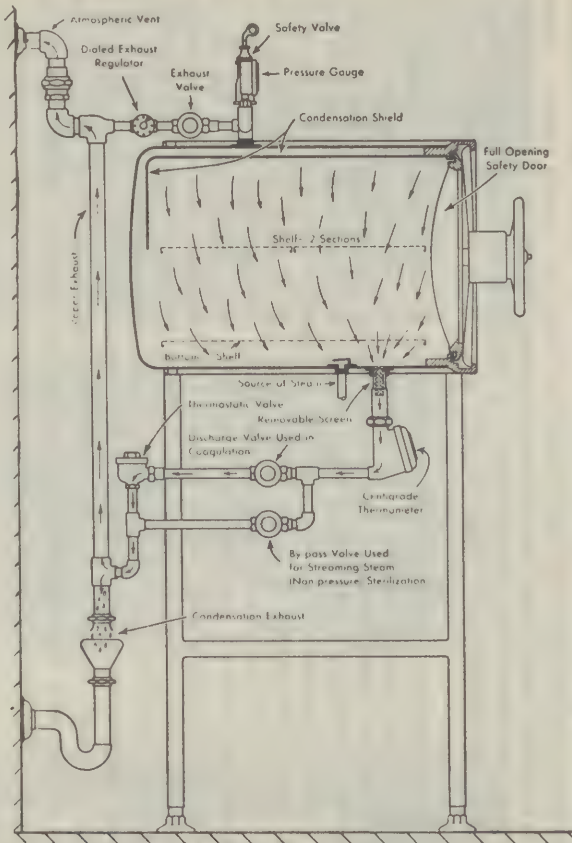
SOURCES OF ENERGY FOR HEATING STERILIZERS - Steam, gas and electricity are the principal mediums used for heating sterilizers. In case the hospital can use high pressure steam for other purposes, and thus justify the maintenance of a power plant, steam by all means should be used for heating the sterilizers. It is the most rapid in operation, and the most economical of the three heating mediums; and besides it can not in any way injure the sterilizers should they boil dry. Where a special steam plant has to be installed to operate the sterilizers, gas and electricity as heating mediums will prove to be more economical. If electric power sufficient to operate the sterilizers is available, electricity is to be preferred to gas.

Under certain conditions none of the above sources of heat may be available, in which case kerosene or gasoline fired stoves are used to heat the sterilizers. Bottled gas may also be used in similiar circumstances.

CONSTRUCTION OF AUTOCLAVE OR DRESSING STERILIZER SUB-BOILER TYPE - The body of the dressing sterilizer is made from two shells which are securely joined together at the front end by means of an accurately machined door collar and ring. It is divided into two main compartments, the sterilizing chamber and the steam jacket. The inner shell, which is closed steam tight at the front end by the sterilizer door, forms the sterilizing chamber. This is the chamber in which the dressings and other surgical supplies are sterilized. The steam jacket is the space between the outer shell and the sterilizing chamber, and is the reservoir for holding the reserve steam that is used in the sterilizing chamber. It entirely surrounds the sterilizing chamber except at the sterilizer door, and with the steam which it contains, serves as an excellent insulator to hold at a constant temperature the steam and mositure used in the chamber during the sterilizing period. Also at the end of the sterilizing period and after the steam has been exhausted from the chamber, steam is retained in the jacket in order to maintain a comparatively high temperature in the chamber and thus facilitate the drying of the goods just sterilized.



Longitudinal section of modern sterilizer. Steam is delivered from the source to the steam jacket, through a pressure regulator which automatically maintains the desired range. The same principle applies for steam heat (as indicated) or for gas or electrically heated sterilizers.



Typical diagram of single wall laboratory sterilizer showing various operating parts. The valving is adapted to every conceivable requirement of the sterilizer.

The steam is supplied to the steam jacket from a sub-boiler or generator attached to the under side of the body of the sterilizer. Here the steam is generated from the water in the sub-boiler by means of a steam heating coil, a gas burner, an electric heating unit, or a gasoline stove.

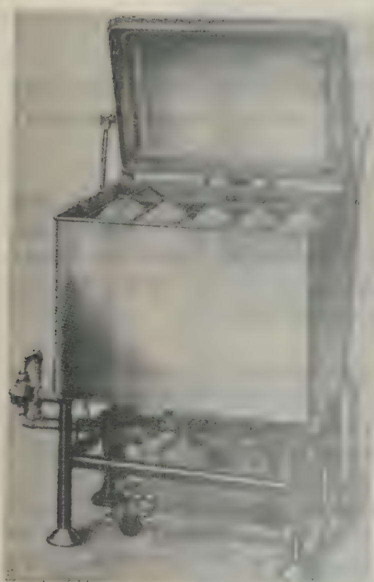
The door impinges on a gasket set in a groove in the end ring, thus making it steam tight. Two gauges are furnished to indicate the steam pressure in the jacket and in the chamber, they are known as the Jacket and Chamber Gauges respectively. A safety "pop" valve is installed in the jacket to relieve any excess pressure generated. Various operating valves are furnished to control the operation of the sterilizer. An automatic air and condensate ejector is furnished on all modern autoclaves.

DRESSING STERILIZER - DIRECT STEAM - In construction, the direct steam heated dressing sterilizer is the same in all respects as the sub-boiler type, with the exception that the sub-boiler is eliminated. Steam at a reduced pressure is introduced into the steam jacket directly from the steam supply line connected to the large boilers in the power plant or in the boiler room of the hospital. A steam strainer is installed on the steam supply line at a point near the back end of the sterilizer, and the steam return line is provided with a thermostatic steam trap and a check valve located on the discharge side of the trap. The steam strainer insures a supply of steam that is clean and free from impurities. The steam trap and check valve not only remove, automatically, the air and condensation from the steam jacket of the sterilizer but also eliminate the effect of any back pressure that may be set up in the steam return line and thus insure the maximum efficiency of the steam used in the sterilizer. A selective pressure automatic steam control valve, installed in the steam supply line between the steam strainer and the body of the sterilizer, is a necessary accessory and insures a constant steam pressure and temperature in the sterilizing chamber during the sterilizing period. No time is lost in the operation of a dressing sterilizer of this type for there is available an unlimited quantity of steam at a pressure that is constant and instantaneous. Such troubles that may arise from the accumulation of lime in the other type of sterilizer is entirely overcome.

To obtain the most efficient results from a dressing sterilizer all the air and the condensation forming in the sterilizer during the sterilizing process must be removed. In the modern sterilizer this is accomplished by the automatic air and condensate ejector. This line is connected into the bottom and near the front end of the sterilizing chamber and is run to the outside air in such a way as to insure perfect drainage. The automatic control of this line is made up of a sensitive thermostatic steam trap which is especially designed for the specific work which it has to perform. From the time the sterilizing period is started until it is completed this valve removes, continually and automatically, the air and all the condensation which forms in the sterilizing chamber and thus insures the maximum efficiency of the steam used in the sterilizing process. There is installed in this line at the point where it leaves the sterilizing chamber, an accurate thermometer. This thermometer enables the operator to keep a check on the temperature maintained in the coolest part of the sterilizing chamber and thus determine if the proper sterilizing temperature is maintained for effective sterilization.

CONSTRUCTION OF AUTOCLAVE SINGLE SHELL OR LABORATORY TYPE - The construction of the single shell autoclave is essentially the same as that of the double shell type with this exception there in only one shell and therefore there is no jacket space. Autoclaves of this construction are primarily intended for use in the laboratory, where the average items to be sterilized do not necessitate a drying process such as is required for dressings, etc. and hence do not require that a high

BULK STERILIZER AND DISINFECTOR



BED PAN STERILIZER
BOILING TYPE

BED PAN WASHER
WALL TYPE

BED PAN WASHER
HOPPER TYPE

temperature be maintained in the chamber for drying purposes after the sterilizing process is completed. A condensation shield contoured to the inside diameter of the chamber is placed within an inch of the top of the chamber and covering its entire inside length. This acts somewhat like a roof placed over the contents of the autoclave and prevents any condensate that may form on the top of the chamber from dropping onto these contents during sterilization. A "shut off" valve is provided on the air and condensate ejector line between the chamber outlet and the trap. The purpose of this valve is to prevent the escape of either steam or air during the process of coagulation and sterilization of blood serum. Since the air is not permitted to escape during this process the sterilizing period has to be considerably lengthened (if the air were allowed to escape during the process bubbles would form in the media). There is also a by-pass valve so connected that when it is opened steam may escape directly to the atmosphere through the air and condensate ejector line as fast as it enters the chamber from the steam supply, by-passing the trap in the air and condensate ejector. This valve is opened when it is desired to perform sterilization by streaming steam (non pressure sterilization).

BULK STERILIZERS AND DISINFECTORS - The general construction, function, and method of operation of these sterilizers is essentially the same as the regular cylindrical autoclaves which we discussed in the preceeding paragraphs. The essential difference is their greater size.

They are generally made of boiler plate either riveted or welded whereas in normal times standard autoclaves are constructed of brass, bronze or stainless steel. These sterilizers also are built in rectangular shape as well as cylindrical and may have a door at each end. When these sterilizers are used as disinfectors, disinfection is accomplished by the use of formaldehyde and ammonia generators attached to and incorporated in the piping system of the apparatus. In many hospitals these bulk sterilizers are used in central supply rooms where a great percentage of routine sterilization takes place. Disinfectors are used for the disinfection and sterilization of mattresses, clothes, etc.

HIGH PRESSURE WATER STERILIZERS

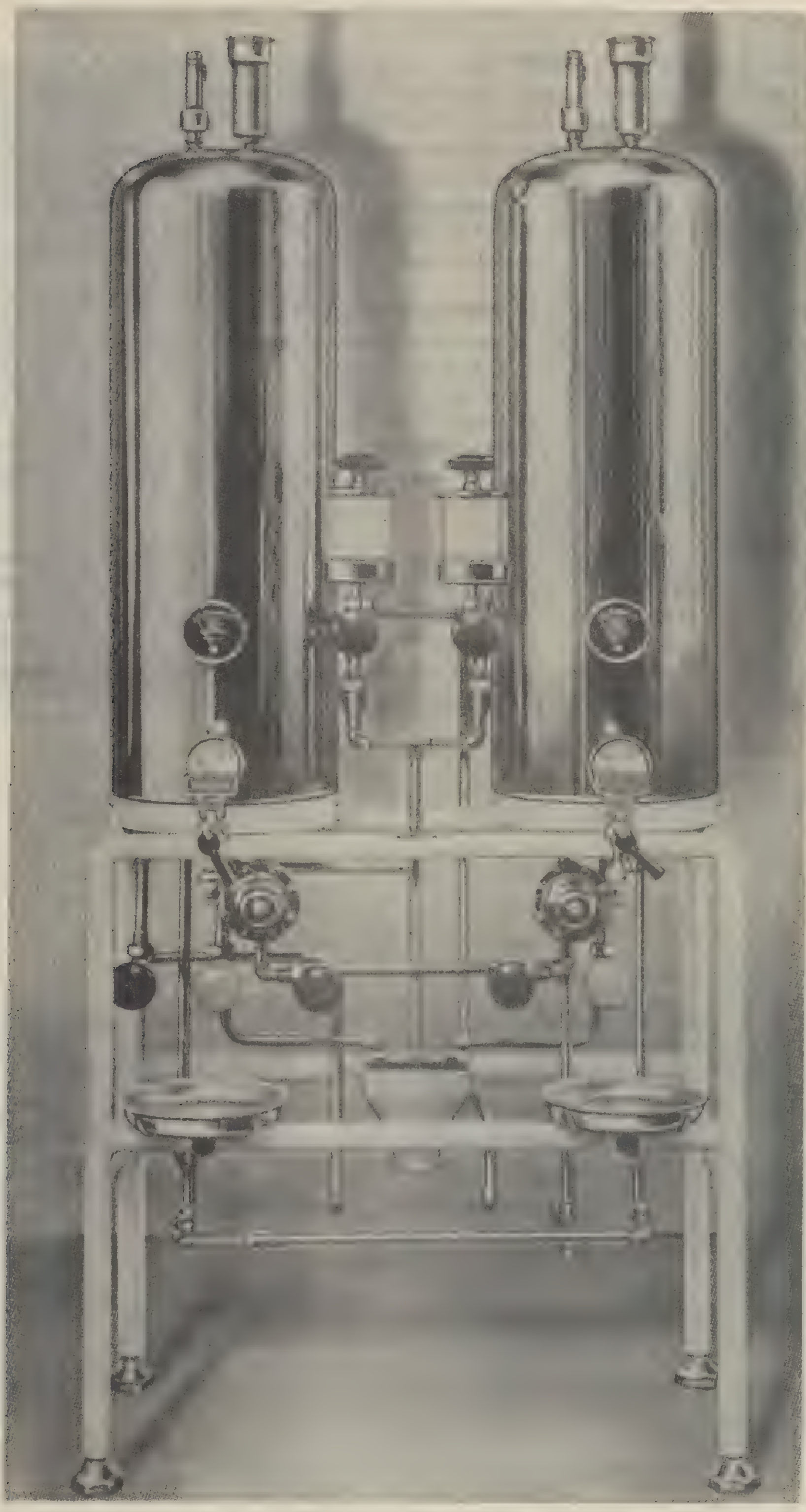
GENERAL METHOD - Sterile water for surgical use is secured by boiling filtered water in a pressure container at 250° to 256° F., (15 to 18 pounds steam pressure) for a period of not less than 10 minutes.

A set of High Pressure Water Sterilizers consists of two tanks, in which the water is sterilized under pressure and stored for future use. The right-hand tank is ordinarily for the sterilization and storage of HOT sterile water, and the left-hand tank for COLD sterile water, a cooling coil being provided in the COLD tank to quickly cool the water after sterilization if needed immediately.

The HOT steam under pressure during the sterilization period sterilizes the entire inner surface of the tank and makes it a safe container for the storage for sterile water. It is obviously necessary that all the articles with which the sterile water comes in contact must be sterile and kept sterile.

Unless the sterile water is required for use immediately after the sterilization period, it is common practice to operate the sterilizers in the afternoon or evening, and allow them to cool down over night. This procedure will save the water required for cooling the COLD tank. The HOT tank may be reheated to 150° to 180° F. as required for use.

All the water used in the first sterilization period after the sterilizers have been installed, or after they have been cleaned or repaired, should not be used for surgical purposes. Waste the water, refill the tanks, and sterilize again before using the water.



PAIR OF WATER STERILIZERS STEAM HEAT

WATER SUPPLY FOR STERILIZERS - The sterilizers are designed to be filled from the city or local pressure water supply. (If the water supply contains a large amount of sediment, a special filter should be installed on the main water supply line to the building.) A filter is provided between the water supply line and the sterilizers, to remove any finely divided sediment. If the sterilizers are filled from a softened hot water supply, the starting time will be materially reduced, and the scale and lime deposit on the inside of the sterilizers will be at a minimum. The cooling coil, however, must be connected to the COLD water supply.

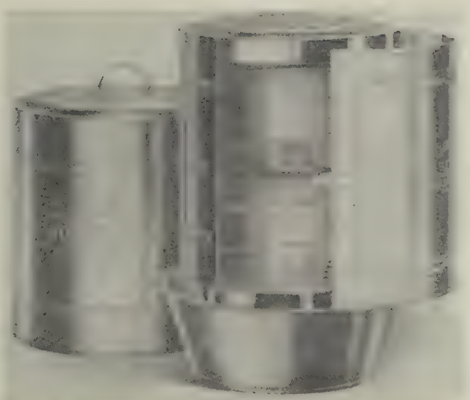
INSTRUMENT AND UTENSIL STERILIZERS NON PRESSURE - These sterilizers are boiling type sterilizers. Their construction is essentially that of a square or oblong box. As the lid is raised, generally by a foot operated lift mechanism, a tray raising mechanism inside the sterilizer automatically raises the tray or trays which are furnished with these type sterilizers. The trays, of course, serve as receptacles in which to place the goods to be sterilized. Sterilization in this case is accomplished by submerging the articles in boiling water for a period sufficiently long to secure adequate sterilization.

MISCELLANEOUS STERILIZERS - The four kinds of sterilizers mentioned above are those which the student will encounter most frequently. They are the four most important types of sterilizers. In addition to these, there are bed-pan washers and sterilizers of various types, combined bottle sterilizers and milk pasteurizers which will be found in the nurseries of hospitals, and finally special service sterilizers such as broncoscope sterilizers, oil sterilizers, hot air sterilizers, etc.

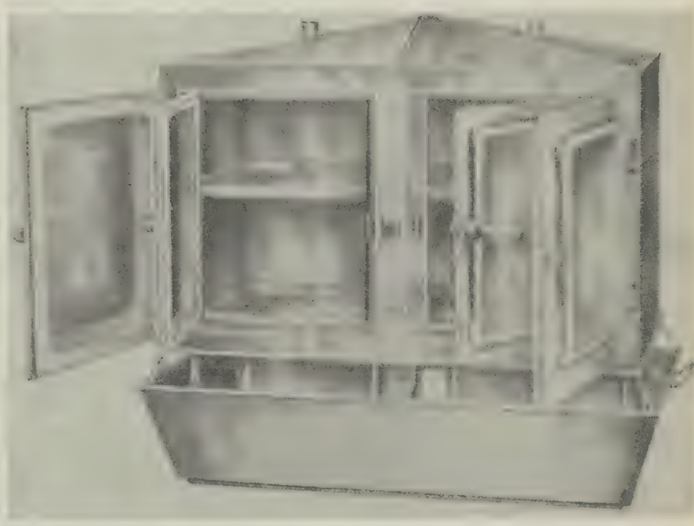
MISCELLANEOUS STERILIZERS

BLANKET, SOLUTION, AND BED PAN WARMER

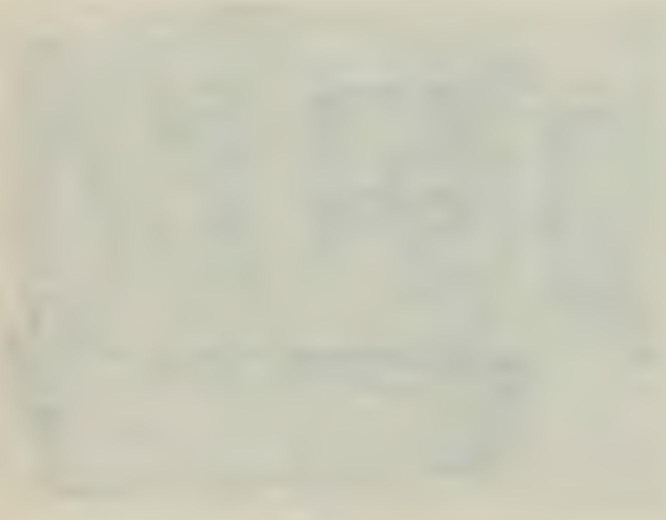
HOT AIR STERILIZER ELECTRIC HEAT

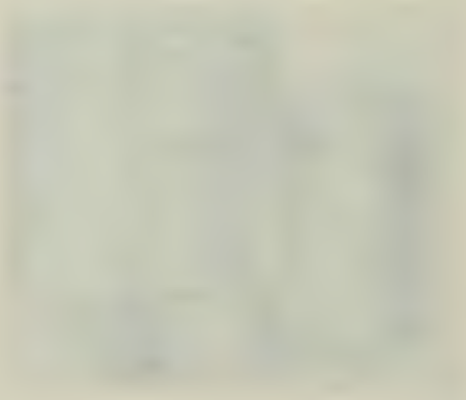


ARNOLD STEAM STERILIZER



ARNOLD STEAM STERILIZER





CHAPTER II

STERILIZERS

SECTION 5

TERMINOLOGY

TERMINOLOGY

AUTOCLAVE STERILIZER
NAMES AND DESCRIPTION OF PARTS AND THEIR FUNCTION
ALL HEATS

BODY	The BODY is double walled consisting of two sturdy cylindrical shells one within the other.
OUTER SHELL	Space between outer shell and inner shell is called the JACKET.
INNER SHELL	Space within the inner shell is called the CHAMBER.
FINISHING JACKET	Surrounds outer shell; performs no function other than for the sake of neatness and appearance.
FRONT END RING	Circular casting with collar to accomodate ends of LOCKING BARS, riveted and sweated into open ends of shells thus sealing the jacket space.
DOOR GASKET	Recessed in groove in END RING.
DOOR HINGE (Articulated)	Fastened to END RING it supports door. It is articulated to assure even contact of door lip with GASKET.
HAND WHEEL	To lock or unlock door HAND WHEEL is turned thus engaging or disengaging LOCKING BARS with or from collar in END RING.
CENTER PLATE	Holds LOCKING BARS in place in ball and socket device.
LOCKING BARS	After door is closed LOCKING BARS are thrown and locked under collar of END RING by rotating the HAND WHEEL. Lip on perimeter of door impinges on GASKET thus making door steam tight.
ACCESSORIES:	
CHAMBER GAUGE	Indicates PRESSURE or VACUUM in CHAMBER.
JACKET GAUGE	Indicates PRESSURE or VACUUM in JACKET.
THERMOMETER	Indicates TEMPERATURE in coolest part of autoclave, and is installed in the AUTOMATIC AIR AND CONDENSATE EJECTOR LINE.
TRAP (Thermostatic - in Automatic Air and Condensate Ejector Line.)	The TRAP contains an expansion element which automatically expands when a certain predetermined temperature is reached to close off the exhaust port. This trap is installed in the AUTOMATIC AIR AND CONDENSATE EJECTOR LINE. As steam is turned into the CHAMBER from the JACKET the air in the CHAMBER is forced out through the AUTOMATIC AIR AND CONDENSATE EJECTOR LINE, the opening to which is located in the lower front part of the autoclave. As long as air, or air mixed with steam passes out

through this line the thermal element in the TRAP will not close because the temperature is not sufficiently high. However, when all air has been ejected and only pure steam strikes the expansion element the TRAP closes and holds the steam in the CHAMBER. During the process of sterilization condensate gathers in this line and permits the expansion element in the TRAP to cool and open thus discharging the condensate. As soon as the condensate is discharged, pure steam again strikes the expansion element and closes the TRAP. This process continues automatically all during the sterilizing period. *(NOTE CAREFULLY)* (A similar TRAP is also installed on the steam return line on all steam heated autoclaves both DIRECT and INDIRECT).

OPERATING VALVES	The various valves required for operating autoclave i.e., STEAM SUPPLY, WATER SUPPLY, DRAIN, VENT, etc.
SAFETY VALVE	Installed on top of autoclave and connected directly to JACKET. Should the pressure in the autoclave become excessive this valve relieves excess pressure. It is set to "pop" at from 22# to 25#.
AIR RELEASE VALVE (Not on all Makes of Sterilizers)	Installed on top of autoclave and connected directly to JACKET. This valve permits air to escape from JACKET as steam is admitted, thus assuring rapid heating. It functions in the same manner as a radiator valve.
CHECK VALVE	Placed in AUTOMATIC AIR AND CONDENSATE EJECTOR LINE between THERMOMETER and TRAP. Without the CHECK VALVE no VACUUM could be drawn, as air would be sucked into CHAMBER through the AUTOMATIC AIR AND CONDENSATE EJECTOR LINE. The CHECK VALVE prevents this. *(NOTE CAREFULLY.* CHECK VALVES are also installed on the steam return line on all steam heated autoclaves DIRECT and INDIRECT). See further under STEAM HEATED AUTOCLAVES.

AUTOCLAVE *DIRECT* STEAM HEAT:

STEAM STRAINER	Placed between steam supply riser and STEAM SUPPLY VALVE. It strains the steam of sediment, scale, etc., before it enters the autoclave thus protecting the steam regulator valve.
STEAM SUPPLY VALVE	This valve is used for turning the steam supply either *ON* or *OFF.*
STEAM REGULATOR VALVE	This valve is installed on steam supply line and is the last valve through which steam passes before entering autoclave. This valve may be set to maintain any predetermined pressure in autoclave.
TRAP (Thermostatic)	This TRAP is installed on the steam return line. Its function is to hold the steam back until it has given

	up its heat and turned into condensate. The condensate is then discharged to this return line. The prime purpose of the TRAP is to ensure maximum efficiency and economy in the use of the steam supply
CHECK VALVE	This CHECK VALVE is placed between the TRAP and the steam return riser. Its function is to prevent any reverse flow of steam caused by back pressure on the return line. Back pressure on the return line might cause the trap to close prematurely and thus prevent it from discharging the condensate into the return line.

AUTOCLAVE *INDIRECT* STEAM HEAT:

STEAM STRAINER	Placed between steam supply riser and STEAM SUPPLY VALVE. It strains the steam of sediment, scale, etc., before it enters the autoclave.
STEAM SUPPLY VALVE	This valve is used for turning the steam supply either ON or OFF and is connected to the incoming end of the STEAM COIL.
STEAM CONTROL VALVE	This valve is installed on the steam supply line to steam coil and according to its setting will maintain the desired pressure in the autoclave.
WATER SUPPLY VALVE	For admitting water to fill GENERATOR.
GENERATOR (or Sub-Boiler) AND STEAM COIL	This is a cylindrical shell sealed at one end, with a removable face plate on the other. In the case of INDIRECT STEAM a STEAM COIL hairpin-shaped, is brazed to the fact plate, and projects into the interior of the generator. This GENERATOR is suspended from the bottom of the autoclave by two pipes each giving access from the interior of the GENERATOR to the JACKET. The GENERATOR is fulled with water through the WATER SUPPLY VALVE. Steam at high pressure, 40# to 60# is allowed to pass through the STEAM COIL thus heating the water in the GENERATOR and developing steam under pressure for use in the autoclave. The flow of steam through the STEAM COIL is started by opening the STEAM SUPPLY VALVE and is regulated by the STEAM CONTROL VALVE.
WATER LEVEL INDICATOR (Either gauge glass or dial type)	Is installed on and is part of the GENERATOR. It indicates water level in GENERATOR and should be watched to see that a proper water level is maintained.
DRAIN VALVE	For draining water from GENERATOR.
TRAP (Thermostatic)	This TRAP is installed on steam return line. (See TRAP Thermostatic) DIRECT STEAM HEAT.
CHECK VALVE	This CHECK VALVE is placed on steam return line between TRAP and the steam return riser. (See CHECK VALVE DIRECT STEAM HEAT).

AUTOCLAVE ELECTRIC HEAT:

WATER SUPPLY VALVE	For admitting water to GENERATOR.
GENERATOR OR SUB-BOILER	Same as in INDIRECT STEAM except that electric heating units are used in place of steam coil. These electric units heat water in GENERATOR and develope steam for use in autoclave.
DRAIN VALVE	For draining water from GENERATOR.
LOW WATER CUT OFF*	This device shuts off current to heaters should water supply in GENERATOR become dangerously low. It thus prevents the heaters from overheating and burning out.
AUTOMATIC CONTROL*	This device regulates the application of current to the heaters and enables the operator to maintain automatically any desired pressure in the autoclave.

AUTOCLAVE GASOLINE OR OIL HEAT:

WATER SUPPLY VALVE	For admitting water to GENERATOR.
GENERATOR OR SUB-BOILER	Same as in electric heat and indirect steam heat except electric heaters or steam coil are replaced by gasoline or oil burners underneath GENERATOR. A gasoline or oil heated GENERATOR is surrounded by a hood to confine the heat of the flames and prevent draft from blowing them out.
WATER LEVEL INDICATOR (Either gauge glass or dial type)	Is installed on and is part of the GENERATOR. It indicates water level in GENERATOR and should be watched closely to see that a proper water level is maintained.
DRAIN VALVE	For draining water from GENERATOR.
OIL OR GAS BURNERS*	These are the portable OIL or GAS BURNERS used to heat the water in the GENERATOR to develope steam for use in the autoclave. They are placed on a rack or shelf beneath the GENERATOR.

WATER STERILIZER
NAMES AND DESCRIPTION OF PARTS AND THEIR FUNCTION
ALL HEATS

BODY COOLING COIL COOLING WATER VALVE	Each pair of water sterilizers comprises two tanks, one commonly called the "hot" tank and one called the "cold" tank. The Cold Tank is so called because it can be cooled down immediately after sterilization by passing cold water through a cooling coil inside the tank. The flow of the water is controlled by the COOLING WATER VALVE.
ACCESSORIES.	
FILTERS	Each tank is furnished with a filter through which the

*For description of various types see under individual manufacturers service data.

	water supply used to fill the tank is passed and filtered before it enters the tank.
THERMOMETER Mercury or Dial Type	A THERMOMETER is installed in each tank to indicate temperature of contents.
SAFETY VALVE	A SAFETY VALVE is furnished for each tank. These are set for from 22# to 25# and will "pop" off should pressure in tank become excessive.
AIR INTAKE AND AIR RELEASE DEVICE*	Each tank is furnished with devices for filtering the air sucked into the tank when water is withdrawn, and for closing the air intake when pressure is built up in the tank.
WATER LEVEL INDICATOR (Either gauge glasses or dial type)	Each tank is equipped either with a Gauge Glass that may be automatically sterilized or with a WATER LEVEL INDICATOR which requires no sterilization. Gauge glasses are equipped with shut off valves at top and bottom in case of breakage, and with a petcock at bottom to drain gauge glass.
FAUCETS	Each tank is equipped with a FAUCET for withdrawing water from the tank as needed.
WATER SUPPLY VALVES	These valves are used to admit or shut off water supply to tanks. These valves are so designed that should they leak or be improperly closed a bleeder pipe will conduct such leakage to the waste system rather than permit it to enter the sterile tanks and thus contaminate them.
DRAIN VALVES	Each tank is fitted with a DRAIN VALVE for emptying the tank.

WATER STERILIZER STEAM HEAT:

STEAM COIL	Each tank is furnished with a STEAM COIL through which high pressure steam may be passed to heat water in sterilizer.
STEAM SUPPLY VALVE	This valve admits or shuts off steam to COIL.
AUTOMATIC CONTROL VALVE*	This valve is located on steam supply line and may be adjusted to automatically keep the water in the sterilizer at any desired pressure during sterilization.
TRAP (Thermostatic)	The TRAP is placed on the return side of the STEAM COIL. (See page 3, TRAP)
CHECK VALVE	See page 3, CHECK VALVE.

WATER STERILIZER ELECTRIC HEAT:

ELECTRIC HEATING ELEMENTS	These replace steam coil as source of heat.

*For description of various type see under individual manufacturers service data.

LOW WATER CUT OFF*	Shuts off current if water should either boil or leak out of tank thus exposing elements to overheating and consequent burning out.
AUTOMATIC CONTROL*	This device regulates the application of current to the heaters and enables the operator to maintain automatically a predetermined temperature in sterilizer.

WATER STERILIZER OIL OR GASOLINE HEAT:

GAS OR OIL BURNERS	These are used as source of heat to develop proper temperature in sterilizer.

INSTRUMENT STERILIZER AND UTENSIL STERILIZERS NAMES AND DESCRIPTION OF PARTS AND THEIR FUNCTION ALL HEATS

BODY	A box-shaped metal container, (Some standard Army sizes. Instrument sterilizer; 24 x 16 x 12. Utensil sterilizer 24 x 20 x 20), to which is attached a lid hinged on the longest side.
TRAY LIFTING MECHANISM	A TRAY LIFTING MECHANISM is incorporated in the body of these sterilizers. As the lid is raised a system of links, guides and gears, raises the tray carrier at the same time.
TRAYS	Removable perforated trays are furnished in which are placed the articles to be sterilized. The 24 x 16 x 12 Instrument Sterilizer has three--one full size, i.e., almost as large as the internal dimensions of the body and two half-size. This gives flexibility in handling instruments. The Utensil Sterilizer, 24 x 20 x 20 has one full size tray.
LID RAISING MECHANISM INSTRUMENT STERILIZER	By depressing a foot pedal, the lid is raised, after it reaches the maximum height a locking device locks the lid open. To close the lid, the lock on the pedal is tripped and the lid descends.
OIL CHECK*	An OIL CHECK prevents the lid slamming and allows it to descend slowly.
LID RAISING MECHANISM UTENSIL STERILIZER*	Utensil sterilizers, because of their larger size and the consequent greater weight of the contents placed in the tray, are furnished with a more elaborate lid raising mechanism of either hydraulic, mechanical or counter-balance type.
OIL CHECK	On the hydraulic type the oil check is incorporated in the pump itself. On the mechanical and counter-balance type a separate oil check is furnished.

*For description of various types see under individual manufacturers service data.

WATER FILLING VALVE	This valve admits water to sterilizer. It is of the bleeder type.
SAFETY WATER FILLING INLET	An air break is incorporated in this device which prevents syphoning of water from sterilizer back into water supply.
OVERFLOW OUTLET AND VENT DRAIN WASTE	These are below the filling inlet. Together with tank drain they are piped to an open funnel forming a complete break at waste connection. This not only prevents syphoning from one sterilizer to another, but also makes it impossible for waste water to back up into a sterilizer should any waste line become clogged.
WASTE VALVE	For draining Sterilizer.
ATMOSPHERIC VENT CONDENSER VENT	For venting excess steam to atmosphere. If atmospheric vent not available, condenser vent may be used. This unit is incorporated in vent outlet of sterilizer. It comprises an ejector operated by cold water. The flow of cold water creates a partial vacuum in the sterilizer sucks the steam from the sterilizer, condenses it and discharges it to the waste line. A separate valve controls the flow of the cold water.

INSTRUMENT AND UTENSIL STERILIZER, STEAM HEAT:

STEAM COIL	A steam coil is located on the floor of the body of the sterilizer, through which high pressure steam may be passed to heat water in sterilizer.
STEAM SUPPLY VALVE	This valve admits or shuts off steam to coil.
TRAPS (Thermostatic)	The TRAP is placed on the return side of the steam coil. (See page 3, TRAP)
CHECK VALVE	See page 3, CHECK VALVE.
EXCESS VAPOR CONTROL*	The object of this control is to prevent excessive vapor caused by too rapid boiling. Its function is to throttle the steam supply to the steam coil as soon as the water in the sterilizer starts boiling. *NOTE:* Boiling water unless contained in a hermetically sealed container can never exceed a temperature of 212° F. (at sea level), so, there is no object in allowing the water to boil violently and dissipate quantities of steam into the sterilizer room where it would be a nuisance.

INSTRUMENT AND UTENSIL STERILIZERS
ELECTRIC HEAT

ELECTRIC HEATING ELEMENTS

These replace steam coil as source of heat.

*For description of various types see under individual manufacturers service data.

LOW WATER CUT OFF	Shuts off current if water should either boil away or leak out of sterilizer thus exposing elements to over heating and consequent burning out.
CONTROL, AUTOMATIC OR MANUAL*	Turns current on and off, also regulates amount of current supplied to heaters thus preventing excess vapor after water has reached boiling point.
CURRENT CONTROL	See previous pages on EXCESS VAPOR CONTROL.

INSTRUMENT AND UTENSIL STERILIZERS
GASOLINE OR OIL HEAT

GASOLINE OR OIL BURNERS.	These are used for heating water in sterilizers and are placed underneath the body of the sterilizer on a rack or shelf.

*For description of various types see under individual manufacturers service data.

CHAPTER II

STERILIZERS

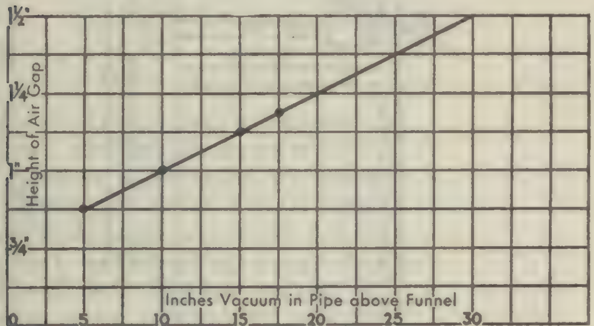
SECTION 6

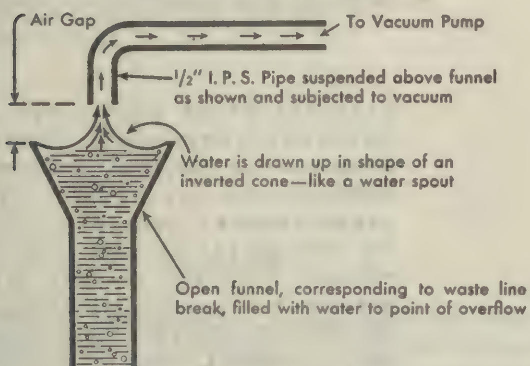
SANITARY PROTECTION OF STERILIZER CONNECTIONS

WATER CONNECTIONS - When a water line feeding various fixtures in a building is drained, or if too many outlets at lower levels are opened simultaneously, some degree of vacuum will exist in the supply line. Nearly everyone has seen this demonstrated at home when the plumber shuts off the water in the basement to make repairs, and faucets are opened to relieve back pressure or vacuum created. The degree of vacuum--the tendency to draw into the supply line impurities which may seriously pollute the piping, is generally not appreciated. To illustrate this point, a 20-foot vertical riser of 1-inch pipe was filled with water, having its upper end closed with a vacuum measuring instrument. Drainage of the water caused a momentary vacuum of 15 inches--equivalent to 1-1/2 pounds per square inch back pressure.

When this occurs, if some fixture, such as a bedpan washer, contains polluted material above the level of the open water inlet, the polluted material will be drawn into the water line. Even if the water level in the fixture is slightly below the water inlet, there is danger of lifting the polluted matter into the supply line--lacking some definite provision to prevent that.

A 15-inch vacuum in a 1/2-inch pipe suspended vertically above a surface of water will cause the water to jump a clear air gap of 1 inch. Upon this little known fact hinges the necessity for much greater protection of water supply lines than is often provided.

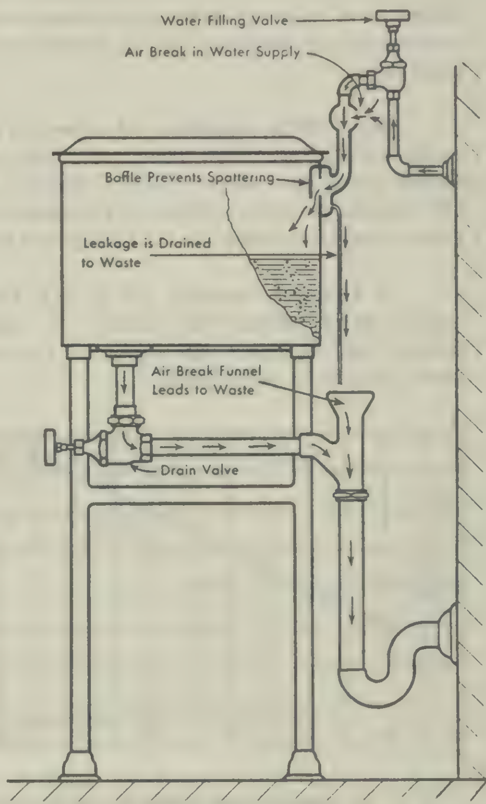




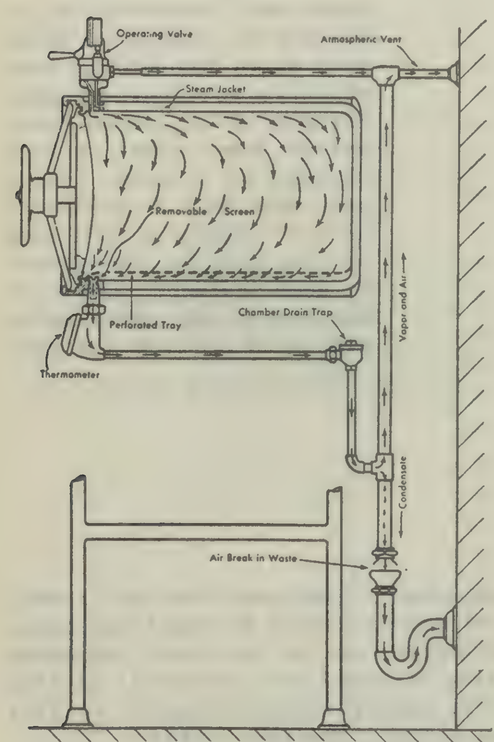
Tests were conducted as indicated in diagram in which were noted the minimum permissible vertical air gaps through which water could not be drawn under various degrees of vacuum. Tests were made with 5-10-15" and 17-1/2" vacuum as indicated by the dots on the chart. In each instance, 1/16" reduction in air gap permitted water to jump the gap.

Check valves will not serve the purpose adequately, because they are rarely tight and are always subject to binding. They are not permitted by exacting codes. Safe protection, simple and free from service failures, lies in the use of an ample air break in the piping--above the fixture. Properly designed and applied it affords permanent protection. Under vacuum, it vents the supply line so that no lifting effort is exerted which might withdraw polluted matter from the fixture.

WASTE CONNECTIONS - Every waste line is subject to clogging and this is notably true of older installations in which much smaller piping was employed than present standards permit. Many outfits of surgical sterilizers are still in use in which combined wastes are no larger than 1/2 inch or 3/4 inch. With such connections the cooling coil on a water sterilizer may easily create back pressure sufficient to cause waste material to back up into other units.



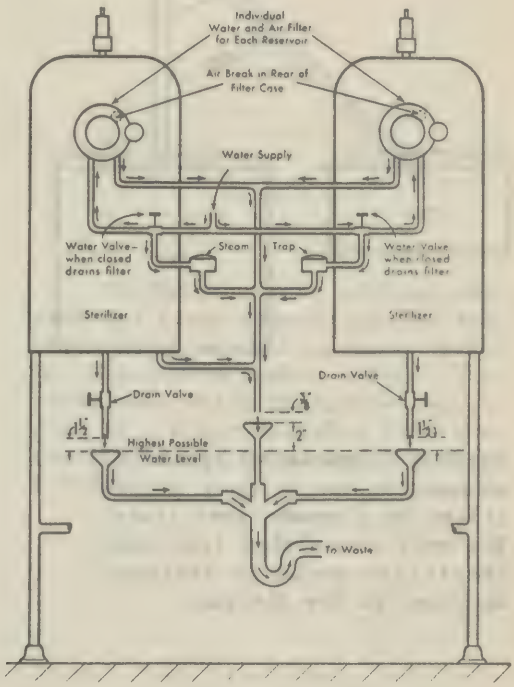
Sanitary Water and Waste Connections to non-pressure units--Instrument, Utensil or Bottle Boilers. The air break in the water connection should be above the top of the sterilizer, and its area several times that of the water connection to it. The Waste Line is 1-1/2" size, and is protected by a funnel break below the sterilizer. The diagram illustrates the functioning of the bleeder line which conducts leakage from the water filling valve direct to the waste system rather than to the sterilizer.



Pressure Steam Sterilizer for Surgical supplies. Typical atmospheric exhaust and waste connections are shown. The steam exhaust connection from the top operating valve and the exhaust from the chamber drain which carries considerable vapor, are both discharged into a common atmospheric vent riser never smaller than 1 inch. The bottom of this common vent riser is drained through an open air-break funnel to the waste. Arrows show the normal movement of steam and air through the sterilizing chamber.

But even when waste lines are of normal size, there is still the possibility of interruption from some source to free drainage and no surgical sterilizer should be considered protected against pollution from the waste--lacking a properly proportioned open air-break between the sterilizer outlet and the waste trap. With such an air-break, back pressure will permit polluted material to escape to the floor, but the sterilizer will be protected. When the waste line is of adequate size there is little danger of overflow.

For any non-pressure surgical sterilizer--instrument or utensil or bottle boiler the air gap between the waste outlet and the top of the funnel need not be greater than 1/4 inch, assuming that the funnel is located below the bottom of the sterilizer. This is true because it is impossible to create any vacuum in such sterilizers which might cause waste material, backed up to the point of overflow, to be drawn into the sterilizer. On the contrary, every pressure sterilizer is normally or abnormally subject to vacuum--10 to 20 inches or more. Should a drainage valve leak under vacuum, and drainage valves often do leak, the protective air-break in the waste must guard against lifting the water from the level of the funnel top through the gap to the sterilizer.

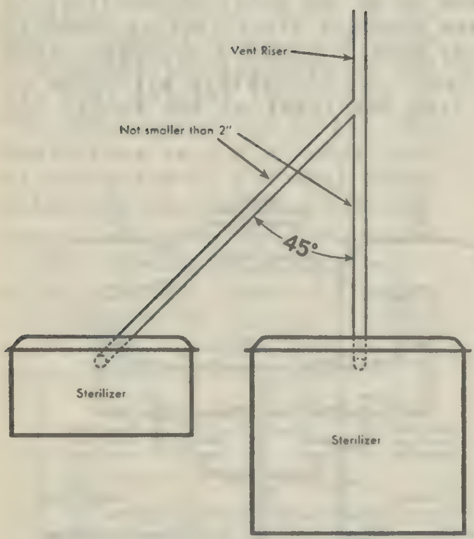


Water Sterilizers--showing water and waste connections. Positive protection of waste systems on water sterilizers requires equivalent of 1-1/2" clear vertical air gap between the outlet point of each drain connection and the highest possible surface level of water in the air-break funnel.

HOW ATMOSPHERIC VENTS ARE DRAINED--TO PREVENT CONDENSATE FROM POLLUTING STERILIZERS - Condensate is created in every vent riser, as steam is discharged from the sterilizer. It is important to prevent its conduction back into sterilizers. Sterilizer atmospheric vents should include an ample sized drain leading from the vent fitting to an air break waste outlet.

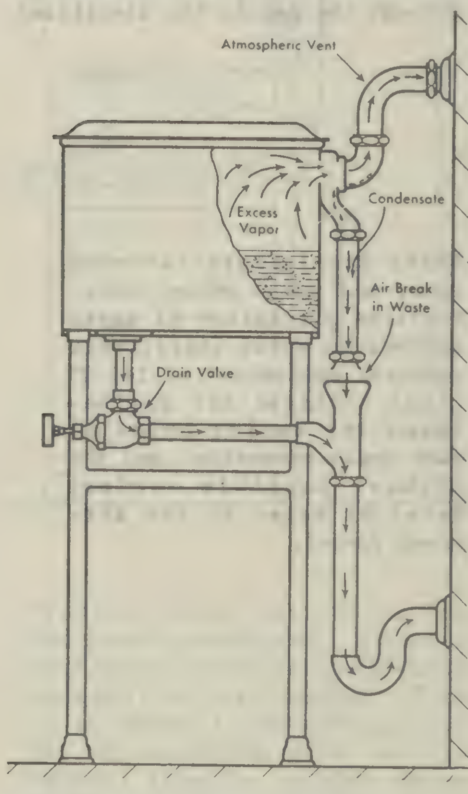
HOW ATMOSPHERIC VENT RISERS SHOULD BE INSTALLED - Failure of atmospheric vents to protect against voluminous discharge of vapor into rooms can nearly always be charged to improper vent risers. The riser, particularly for non-pressure sterilizers, must be free from long horizontal runs which retard free passage of vapor.

The correct riser is conducted vertically to the roof, or if side runs are necessary, they are sloped upward at angles of 45 degrees from the horizontal. If two or more units in one room are connected to a common riser, the connections should be made as indicated.



Showing recommended system of connecting two or more sterilizers to a common vent riser. The vent connection from each sterilizer would be drained, as shown in the diagram.

Showing sanitary application of atmospheric vent to non-pressure sterilizer. A baffle in the vent fitting directs the flow of condensate to the waste--avoids pollution of the sterilizer.



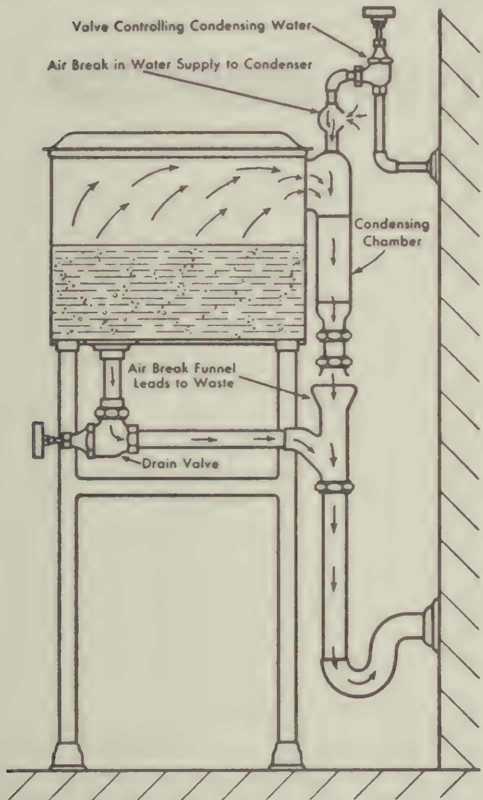
The vent outlet from any non-pressure sterilizer should not be smaller than 2 inches. For the usual surgical supply (pressure unit) the size should be 1 inch.

CONDENSER VENTS FOR EXHAUST OF EXCESS STEAM FROM STERILIZERS - These serve a very useful purpose for certain applications but are recommended only for non-pressure sterilizers--instrument, utensil, bedpan steamers, or those which use the boiling method--similar to utensil sterilizers. They cannot be used satisfactorily for bedpan sterilizers because they cannot absorb odors. They can be applied readily to pressure sterilizers for surgical supplies but the atmospheric vent is much to be preferred.

The condenser vent consists of a condensing chamber attached to the vent outlet from the sterilizer, through which excess steam is drawn by slight suction created by a small stream of water discharged through a Venturi tube. Excess steam is condensed and carried to the waste through a suitably large connection.

Properly applied condensers will vent non-pressure sterilizers more effectively than the average atmospheric vent, because few atmospheric vents have free access to the atmosphere except through restrictions in the shape of side runs which impair natural pull of the chimney effect intended. For non-pressure units, particularly those located in utility rooms remote from vent risers, condenser vents have largely replaced the atmospheric type.

AUTOMATIC CONTROL FOR THE CONDENSER VENT - The greatest objection in the past to use of condenser vents has resulted from operators forgetting to open condensing water valves, and filling rooms with steam. Automatic control is now available by means of which the condensing water is turned on and off as the heat is turned on and off.



Condenser vents utilize the same air break protection for the water inlet as that used for filling the chamber with water. The condensing water discharge serves also as a water overflow from the sterilizer--is never smaller than 1 inch.

CHAPTER II

STERILIZERS

SECTION 7

METHODS OF HEATING STERILIZERS

COMMONLY USED METHODS OF HEATING STERILIZERS - are pressure steam, electricity and gas, and these methods are popular in the order named.

In large hospitals pressure steam is used for laundry equipment and for some forms of cookers, and when provided for other purposes, it is invariably less expensive and more satisfactory for heating sterilizers than electricity or gas.

GAS HEAT - Gas was formerly used extensively for sterilizers, but that practice is no longer popular, because of the explosion hazard, and also because of the heat, dirt and fumes which can never be entirely eliminated.

ELECTRICALLY HEATED STERILIZERS - have been greatly improved in recent years. Heaters are so stable and well protected that danger of burn-out with consequent expensive maintenance is no longer serious. Heaters are so applied that very little heat is wasted and the speed of operation is much better than gas--closely approaching pressure steam. Automatic control has proved to be an excellent time and power saver.

Small hospitals and larger ones too, in many localities, find a distinct saving in operating costs by using electrically rather than steam heated sterilizers, particularly where the supply room is well organized. A statement about relative costs cannot be made with intelligence, lacking knowledge of all the facts applying, but usually it is safe to assume that if the hospital must provide pressure steam for other purposes throughout the year, then the sterilizers should be heated by steam as an obvious matter of economy. If, however, the pressure steam system could be eliminated, except for sterilizers, then--if electric power is available at a reasonable rate--it will be economical to use electric power. In some institutions, pressure steam is available only during winter months and the attempt is made to heat sterilizers by both steam and electricity. This can be done, but the system is too complicated. Usually in such cases, analysis will show that the heating system can be changed to low pressure advantageously and the sterilizers heated all the year round by electricity.

One important consideration favorable to electric sterilizers is that electric power can usually be supplied at any part of a building with much less difficulty and expense initially than steam. For this reason alone, some institutions now use steam for the main surgical sterilizers and electricity for those utility rooms located in wings remote from steam risers.

GASOLINE AND KEROSENE HEATED STERILIZERS

Occasionally it will be necessary to install sterilizers in a location where none of the above common sources of heat are obtainable. This source of heat is sometimes used by the Army in semi-permanent hospitals in remote war areas, and for this reason the application of gasoline and kerosene heat to sterilizers will be discussed in the following pages. The most commonly employed gasoline and kerosene heaters for this purpose are the "Primus Stove" and the "Coleman Gasoline Stove". The obvious disadvantages of this form of heating are as follows: There is no method of automatically controlling the flame under the sterilizers and therefore it is impossible to make any provision for an automatic means of shutting off the source of heat should the water be boiled out of the sterilizer, therefore it is of the greatest importance that the operator pay strict attention to the water level, otherwise he may very easily allow the sterilizers to boil dry and thus be seriously damaged.

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CHAPTER II

STERILIZERS

SECTION 8

APPROXIMATE POWER CONSUMPTION STEAM, GAS, AND ELECTRIC HEAT

APPROXIMATE POWER CONSUMPTION OF STERILIZERS USING STEAM, GAS AND ELECTRIC HEAT

PRESSURE STEAM STERILIZERS FOR SURGICAL SUPPLIES
Sterilizing period 30 minutes at 240° - 250°F.

Size Sterilizer	STEAM HEAT at 40 Lbs. Pressure	GAS HEAT 600 B.T.U. per Cu. Ft.	ELECTRIC HEAT	
	Lbs. of Steam for One Performance	Cu. Ft. Gas for One Performance	Capacity Heater in watts	K.W. Hours for One Performance
12" x 20"	11	20	4500	2.25
14" x 22"	14	26	6000	2.87
16" x 24"	19	35	9000	3.84
16" x 36"	27	50	9000	5.54
20" x 28"	30	55	9000	6.03
20" x 36"	39	72	12000	7.89
20" x 48"	49	90	12000	9.84
20" x 60"	62	113	12000	12.49

PRESSURE INSTRUMENT STERILIZER
Sterilizing period 10 minutes at 240° - 250°F.

12" x 20"	8	15	4500	1.6
14" x 22"	10	17	6000	1.9
16" x 24"	12	22	9000	2.45

PRESSURE LABORATORY STERILIZER (AUTOCLAVE)
Sterilizing period 30 minutes at 240° - 250°F.

15½" x 24"	12	15	6000	2.5
17½" x 26"	16	17	9000	3.2
21½" x 30"	20	22	9000	4.0

WATER STERILIZERS--ONE RESERVOIR ONLY
Starting with water at 70°F. and maintaining temperature 240° - 250°F. for 15 minutes.

6-gallon	19	35	4500	3.4
10-gallon	30	56	6000	5.46
15-gallon	45	82	9000	8.05
25-gallon	75	136	12000	13.36
50-gallon	150	275	12000	26.83

NON-PRESSURE INSTRUMENT AND UTENSIL STERILIZERS
Starting with water at 70°F. and maintenance of vigorous boiling for 20 minutes.

8" x 9" x 18"	9	16	3000	1.7
9" x 10" x 20"	10	18	4500	2.0
10" x 12" x 22"	13	23	6000	2.5
12" x 16" x 24"	20	37	9000	4.0
10" x 12" x 36"	22	39	6000	4.3
16" x 15" x 20"	31	57	6000	6.2
20" x 20" x 24"	48	87	9000	9.6

APPROXIMATE POWER CONSUMPTION OF STERILIZERS USING STEAM, GAS AND ELECTRIC HEAT

STEAM CONSUMPTION FOR RECTANGULAR STERILIZERS AND DISINFECTORS

The steam consumption for Rectangular Sterilizers and Disinfectors is given by horse power instead of pounds of steam.

RECTANGULAR STERILIZERS

Size of Sterilizers	H. P.
24" x 24" x 36"	1.50
24" x 24" x 48"	2.00
24" x 24" x 60"	2.50
24" x 36" x 48"	3.50
24" x 36" x 60"	4.00
24" x 36" x 72"	4.75

DISINFECTORS

30" x 42" x 84"	5.50
30" x 48" x 84"	6.00
36" x 42" x 84"	6.00
42" x 48" x 96"	7.25
48" x 54" x 96"	8.50
48" x 60" x 96"	9.50
60" x 66" x 96"	10.50

CYLINDRICAL DISINFECTORS

25" x 66"	3.00
30" x 86"	4.00
36" x 88"	5.00
40" x 93"	5.50
48" x 93"	7.00
56" x 93"	8.00
60" x 108"	9.50
60" x 222"	19.00

Steam consumption for all the Rectangular and Cylindrical Sterilizers and Disinfectors is based on h.p. for either one performance or continuous operations.

CHAPTER II

STERILIZERS

SECTION 9

HEATING STERILIZERS WITH PRESSURE STEAM

HEATING STERILIZERS WITH PRESSURE STEAM

BOILER PRESSURE REQUIREMENTS - Modern steam heated sterilizers require an operating pressure of from 40 lbs. to 60 lbs. *at the sterilizers*. Satisfactory performance will not result from pressure below 35 lbs. Obviously it is impossible to operate sterilizing equipment with steam supplied by low pressure (2 lbs. to 15 lbs.) steam heating systems. On the other hand, steam pressure at the sterilizers should not exceed 65 lbs. and when it does, a pressure reducing valve should be installed in the steam supply line to maintain the pressure at the sterilizers within the limits of 40 lbs. to 60 lbs. Care should be taken to avoid excessive fluctuations in boiler pressure and supply lines should be of sufficient capacity to serve the demands of the equipment. Minor fluctuations are controlled by pressure regulating valves supplied as standard equipment on all modern sterilizers.

Owing to widely varying conditions, it is difficult to give any table of steam consumption that will provide an accurate guide in figuring boiler sizes for given numbers of steam heated sterilizers. In the majority of larger hospitals, boilers are provided that are rated well above average requirements and will handle all sterilizing equipment necessary without difficulty. Generally speaking, small hospitals planning on installing an automatic boiler to operate sterilizers will find that a 4 to 6 horse-power boiler will be ample for these requirements.

STEAM SUPPLY SYSTEM - Steam supply lines should be well insulated and of sufficient size to prevent condensate from being carried to the sterilizers. This is particularly important with autoclaves, as steam charged with condensate will cause wet dressings and unsatisfactory performance. A large steam supply line decreases the velocity at which the steam travels and permits the condensate to return by gravity to some low point where it should be trapped and drained into the steam return system.

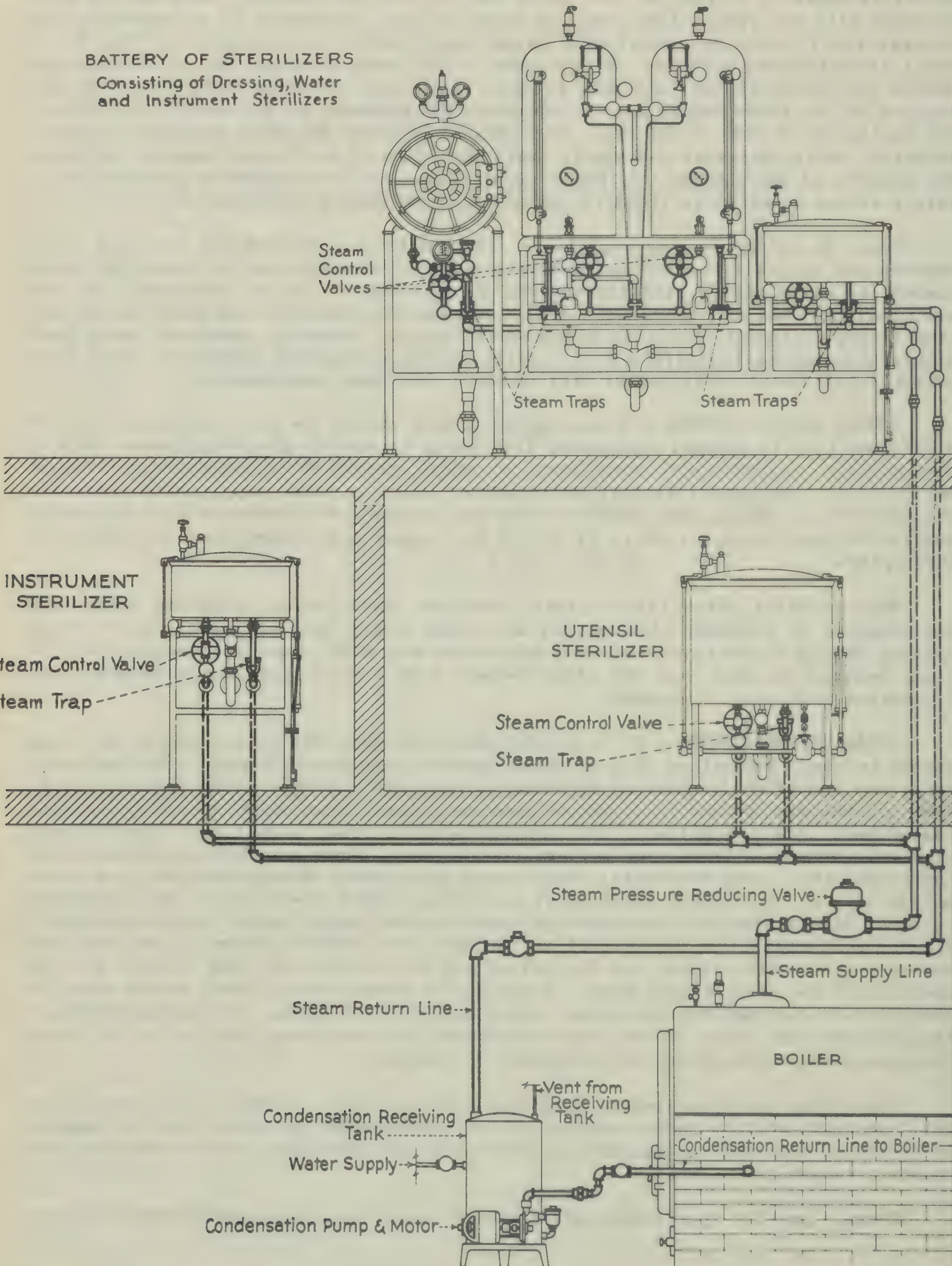
Where several batteries of sterilizers are installed on different floors and are supplied by a common steam supply and steam return system, the piping of these systems should be designed and laid out to conform with sound engineering principles, bearing in mind that the steam demand from sterilizers is not constant but fluctuates from zero to maximum.

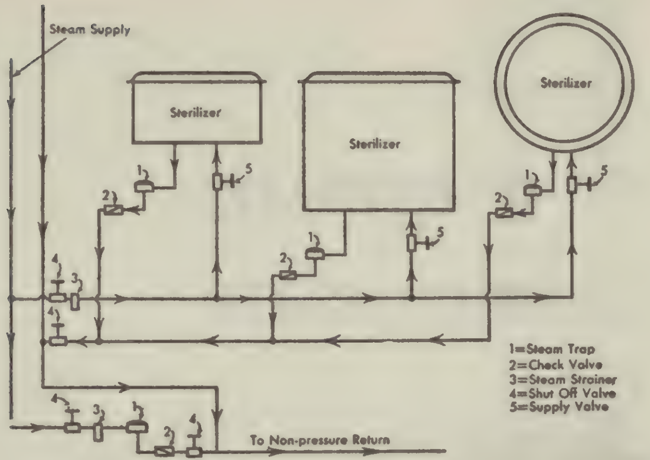
STEAM RETURN SYSTEM - It is highly important that the proper system of steam return be used, and unless this is done, trouble will surely result. The most satisfactory operation is secured by using an open gravity type steam return system, draining the condensate to a vented receiving tank, from which the condensate is pumped back into the boiler. This system permits free, normal operation of each trap and prevents interference between sterilizers. Steam return lines should be of ample capacity. Long horizontal runs, bends and pockets where condensate may accumulate should be avoided as much as possible. Most sterilizers are regularly equipped with individual thermostatic steam return traps, which insure a constant flow of condensate from the sterilizer to the steam return system. They are also equipped with check valves, but the latter may not protect the trap in case of back pressure on the steam return line. Individually trapped sterilizers should never be connected to a steam return system having any back pressure, to a system having a trap between the traps on the sterilizers and the receiving tank, or to a return line connected to equipment not individually trapped.

Connecting the steam return line from the sterilizer or battery of sterilizers to a vacuum type steam return system is not recommended, as widely varying amounts of discharge from the sterilizers may seriously interfere with the maintenance of a constant vacuum in the system.

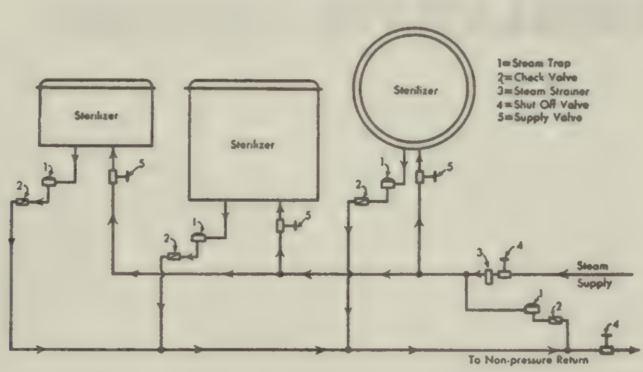
Where a gravity type steam return is not available, autoclaves should be piped

to discharge the condensate into waste line, through an open air break waste fitting to deep seal trap.





When sterilizers are fed from adjacent supply risers, application of suitable traps as indicated by this diagram will keep the risers filled with normal steam. The system should always be protected by a steam strainer and accessible shut-off valve as shown. This diagram also indicates the recommended system for trapping individual units to the return.



When sterilizers are fed from long horizontal runs of supply piping, the lines can be kept free from condensate by the trapping method indicated by this diagram.

STERILIZER RETURNS SHOULD BE NON-PRESSURE--DISCHARGING INTO A VENTED RECEIVER - It is generally conceded that pressure returns are obsolete, that each sterilizer should be individually trapped to a return free from pressure, with the least possible retardation of free, gravity flow of condensate from the heating coil or steam jacket. The Figures above denote the method recommended for trapping each unit. It is important to provide a swing check valve back of each trap as shown, to protect the trap from back-flow of steam or vapor which might affect its functioning.

CHAPTER II

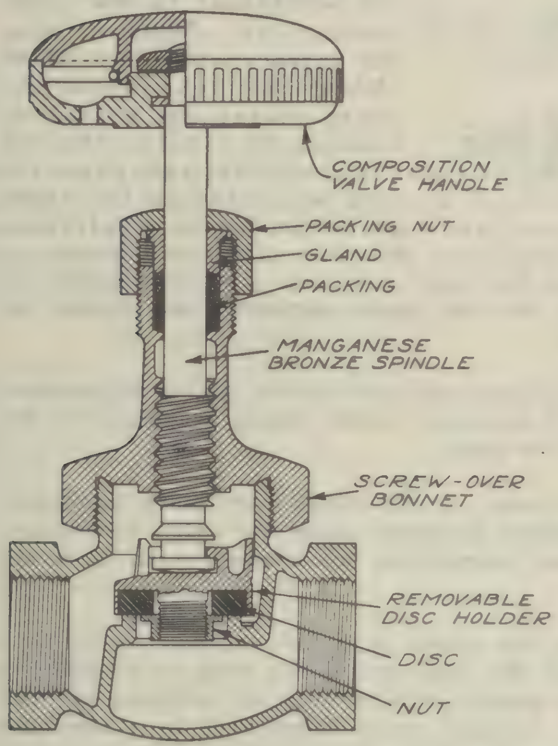
STERILIZERS

SECTION 10

ACCESSORIES ON STEAM HEATED STERILIZERS

OPERATING VALVES

OPERATING VALVES ON STERILIZERS - The SPINDLE is kept steam-tight by means of the PACKING which is held tightly in place by the GLAND and the PACKING NUT. The PACKING NUT should be tightened occasionally to prevent leaks. (The nut should turn easily with a wrench and should be tightened only enough to prevent steam or water from escaping around the SPINDLE and still leave the SPINDLE so it will rotate easily by hand). If the PACKING NUT cannot be tightened sufficiently to stop the leak, remove the PACKING NUT and the GLAND, and replace the old PACKING with a new one of an approved type which may be secured at any hardware or plumbing shop.



If the REMOVABLE DISC becomes worn and hard and the valve fails to close tightly, the DISC should be removed and a new disc put in.

To replace the DISC: Open the valve by turning the valve handle to the left, about two turns; unscrew the SCREW OVER BONNET: then, by turning the valve handle back to the right, the disc holder will drop out. Unscrew the nut holding the disc to the holder and remove the disc, put in a new disc, and reverse the operation to reassemble the valve. It is important that the correct size and type of DISC be put in. Valves used on STEAM or HOT WATER lines require a disc designed for "hot" service. Before reassembling the valve, as above outlined, examine the VALVE SEAT for cracks and chips. If the seat is cracked or grooved, a new valve body should be installed.

Keep the LOCK NUT tight which holds the valve handle on the SPINDLE.

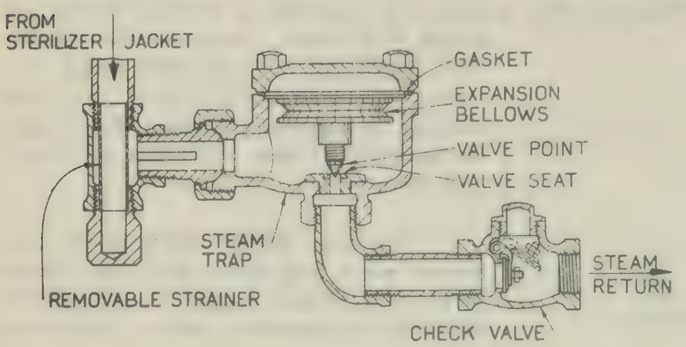
This lock nut is concealed under the valve handle cover. Some covers are of the snap-on type and may be removed readily by inserting a knife or screw-driver between the valve handle and the cover.

On recessed sterilizers, the valves are equipped with extension stems projecting through the recessing wall. These should be inspected occasionally and the lock nuts on the extension yokes tightened.

Keep all operating valves in good condition.

THERMOSTATIC STEAM TRAP, CHECK VALVE AND STEAM STRAINER

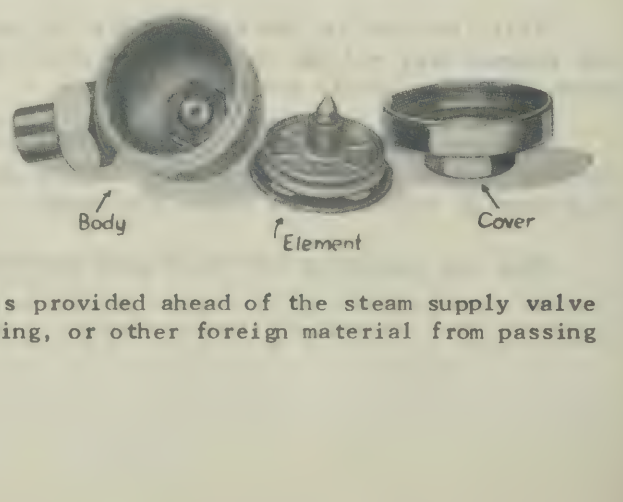
STEAM TRAP AND CHECK VALVE - Each steam heated sterilizer should be equipped with a thermostatic steam trap for trapping and returning the condensed steam through the steam return system back to the boiler. The trap consists of a small valve which is operated by an expansion bellows. When the trap is cold, the valve in the trap is open, permitting steam, when admitted to the sterilizer, to have free passage through the sterilizer to the steam return line. However, when the steam reaches the STEAM TRAP, the heat from the steam causes the expansion bellows to expand, thereby closing the valve to the trap and allowing the steam to remain in the sterilizer. As the steam condenses in the sterilizer, the condensation drains into the trap, and since the condensation is colder than steam, the expansion bellows in the trap again contracts, permitting the condensation to flow into the return system.



A check valve is installed between the trap and the return system to prevent the condensation from other sterilizers or equipment from draining back into the trap and interfering with the operation of the trap.

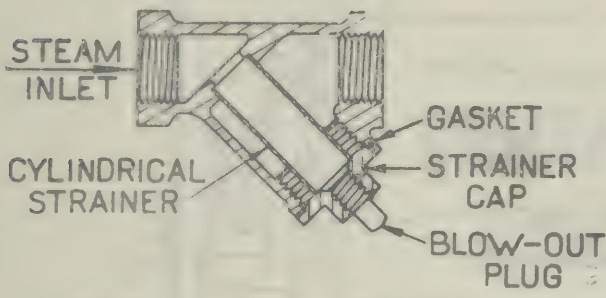
It is highly essential that the valve seat in the steam trap seats properly. To ascertain whether or not the trap is working properly, open the union connection between the trap and the steam return line, permitting the condensation to drain into a pan or pail for a few minutes.

If the trap is working properly, when the steam is turned on there will be a rush of air, water, and then steam through the trap until the trap is thoroughly heated, after which the valve in the trap should partially close, shuting off the hot steam and ejecting the condensation. In most cases there will be a constant drip or flow of condensation, varying in quantity and speed, with a small amount of steam. Do not mistake the vapor from the hot water for live steam. If the trap fails to close and there is a constant rush of hot steam, the trap is not working properly and should be repaired or replaced. (Scale or dirt from the pipe lines will prevent the valve in the trap from closing; therefore a strainer and dirt pocket should be placed ahead of each trap. This strainer may be cleaned by removing the hexagon nut in the bottom of the tee ahead of the trap.) Also remove the expansion bellows and inspect the valve point and valve seat. If these are clean and the trap should fail to function properly when put together again, replace the bellows with a new one or replace the entire trap.



STEAM STRAINER - A steam strainer is provided ahead of the steam supply valve to prevent sediment, scale, bits of packing, or other foreign material from passing

into the steam control valve or the steam trap.



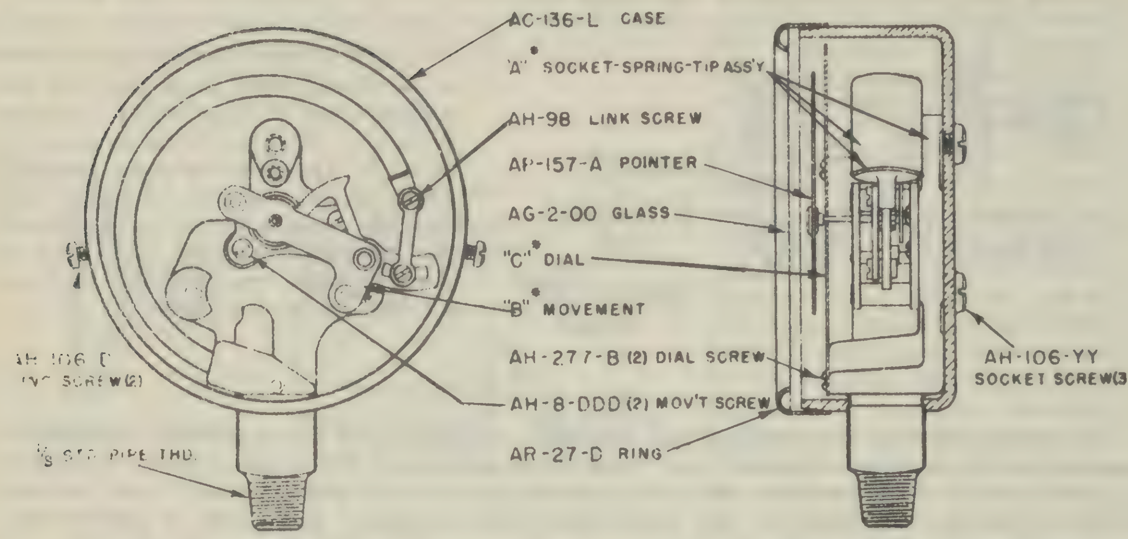
To clean the strainer, remove the blowout plug and let the steam blow through this opening freely. Quite frequently, it will be found to be more convenient to remove the strainer cap and to take out the cylindrical screen and clean it. This can be done without removing the strainer body from the line.

STEAM CONTROL AND REGULATING VALVES - Inasmuch as the various sterilizer manufacturers use steam control and regulating valves of different design the reader is referred to the special sections further on in this manual where the various accessories used by each of the individual manufacturers are treated separately.

EXCESS VAPOR CONTROL
See paragraph above

SAFETY VALVES
See paragraph above

ALL MAKES PRESSURE GAUGES




AD 9980


AD 9978

*	30# PRESSURE GAGE	30" - 30# COMPOUND GAGE
A	ANS-1108-CA	ANS-1108-CB
B	AM-130	AM-130-E
C	AD-9980	AD-9978

OPERATION - Gages used on sterilizers are standard bourdon pressure and compound gages. Pressure entering gage at 1/8 pipe conn. passes through socket into bourdon tube which has a tendency to straighten out when subjected to pressure, and to coil up when evacuated. Motion of bourdon tube is transmitted to pointer and amplified through movement - link assembly. Do not subject gage to overpressure.

ADJUSTMENT - If error is uniform over entire scale, remove ring and glass, pry off and reset pointer. If pointer travel is not sufficient, remove internals from case and loosen link screw, carefully slide link screw in slot toward the pivot. If pointer travel is too great slide link away from pivot and tighten. If correct travel cannot be obtained, bourdon tube is probably deformed and gage should be replaced.

No servicing required other than occasional retesting for accuracy. Use no oil. If pointer does not travel smoothly bearings or teeth are either dirty or worn. Parts may be cleaned by dipping in a volatile liquid.

CHAPTER II

STERILIZERS

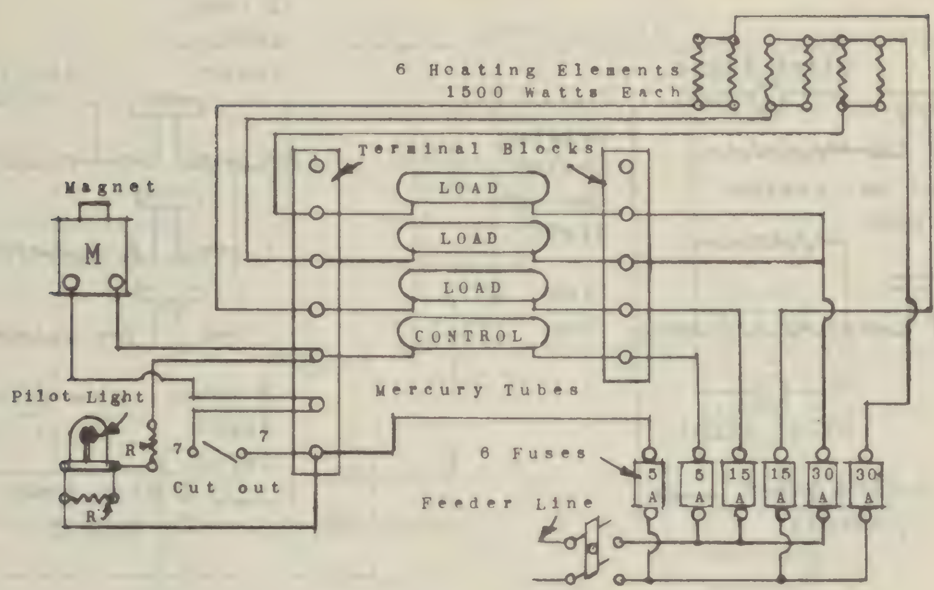
SECTION 11

ELECTRIC STERILIZER CIRCUITS

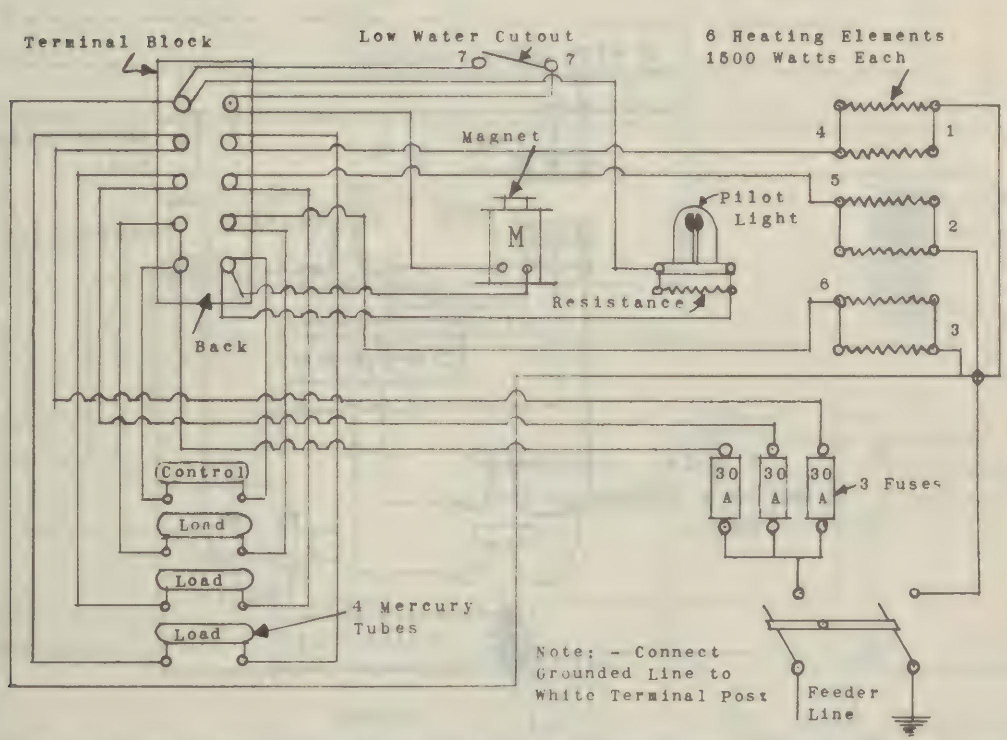
ELECTRIC STERILIZER CIRCUITS

AMERICAN STERILIZER

BASIC ELECTRIC CIRCUITS



PRESSURE STERILIZERS



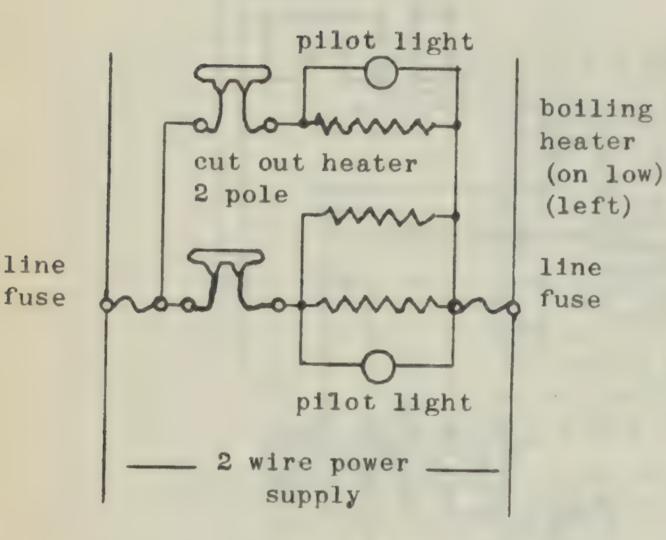
NON PRESSURE STERILIZERS

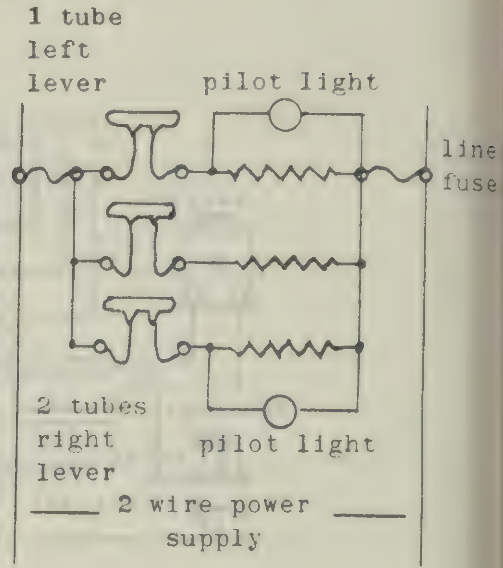
F-8613

ELECTRIC STERILIZER CIRCUITS

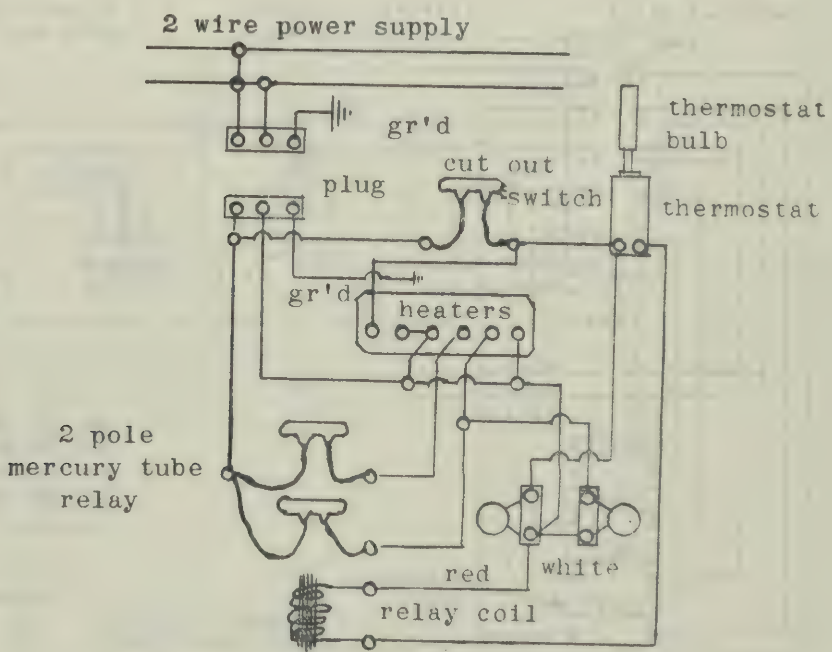
SCANLAN MORRIS

ELECTRIC CIRCUITS - NON PRESSURE STERILIZERS





CIRCUITS. MANUAL HEAT CONTROL INSTRUMENT OR UTENSIL STERILIZERS

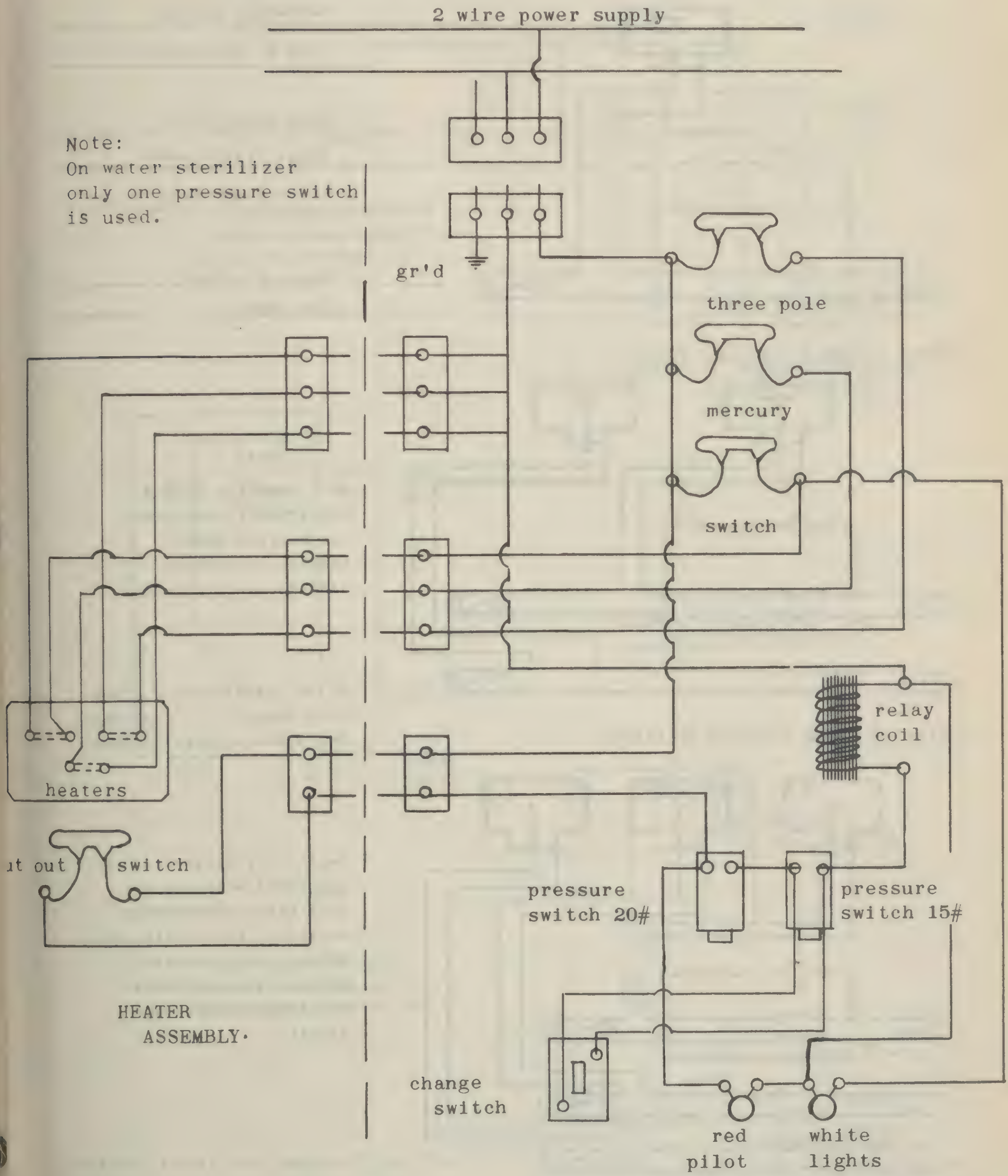


CIRCUIT. "VENTOSTAT" AUTOMATIC EXCESS VAPOUR CONTROL (IN LIEU OF VENT)

ELECTRIC STERILIZER CIRCUITS

SCANLAN MORRIS

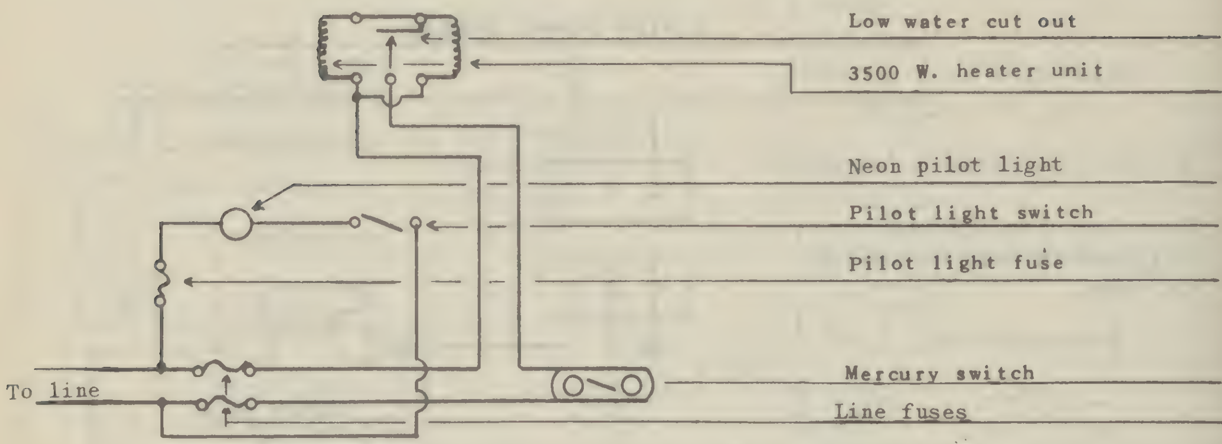
ELECTRIC CIRCUITS - PRESSURE STERILIZERS



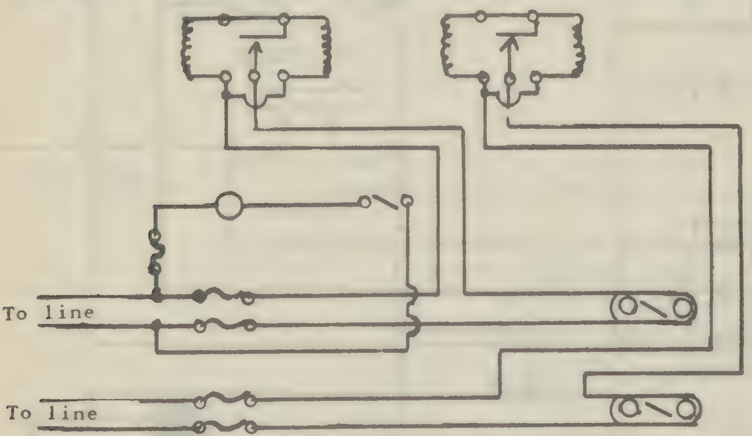
ELECTRIC STERILIZER CIRCUITS

WILMOT CASTLE

ELECTRIC CIRCUITS FOR PRESSURE STERILIZERS



WIRING DIAGRAM FOR ONE HEATER

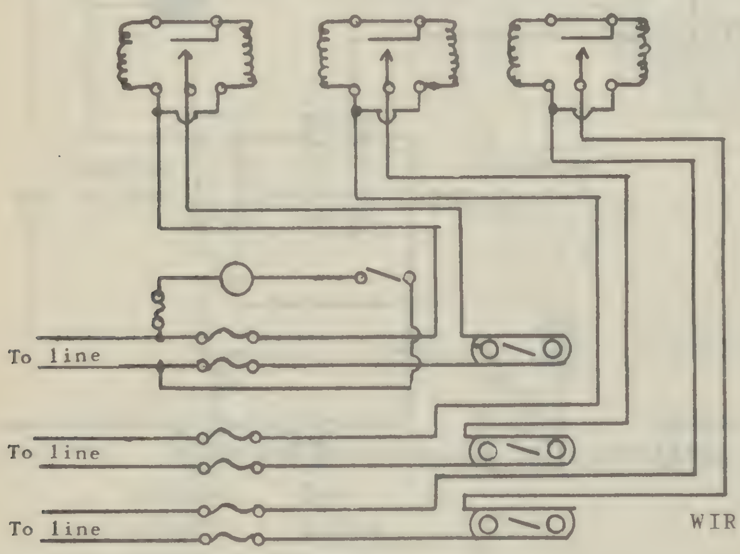


Note

Each complete 3500 W heater unit comprises two hairpin shaped heater elements of 1750 W capacity each.

Pilot light fuse	5 amp
Line fuses	20 amps
Cap Mercury tubes	20 amps

WIRING DIAGRAM FOR TWO HEATERS



Castle sterilizers are furnished with one or more heaters depending on size. Each heater is wired in an identical circuit and each heater is independent of the others.

WIRING DIAGRAM FOR THREE HEATERS

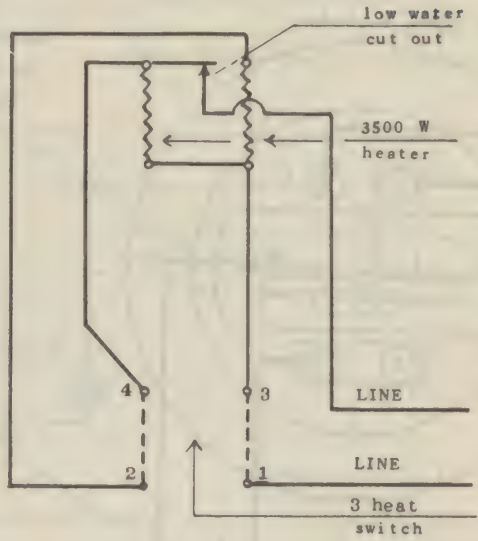
ELECTRIC STERILIZER CIRCUITS

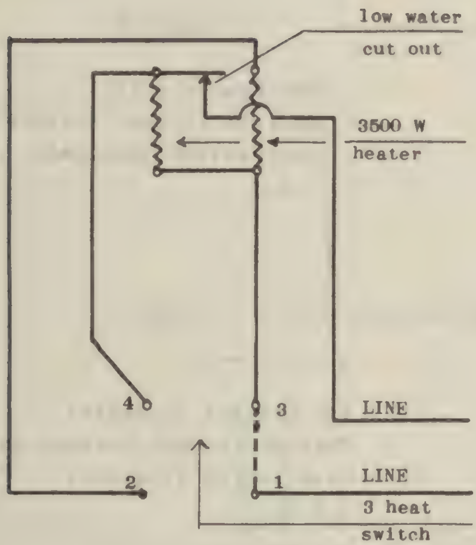
WILMOT CASTLE

ELECTRIC CIRCUIT FOR NON PRESSURE STERILIZERS

HIGH

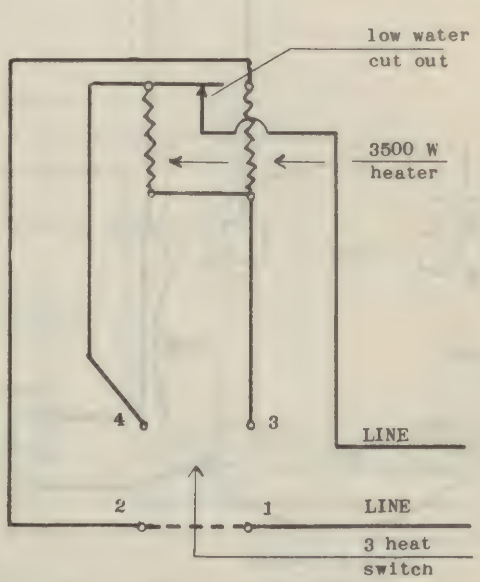
Heaters in Parallel
Contact is made between three
Heat switch terminals 1 & 3 - 2 & 4





MEDIUM

One heater only
Contact is made between three
Heat switch terminals 1 & 3



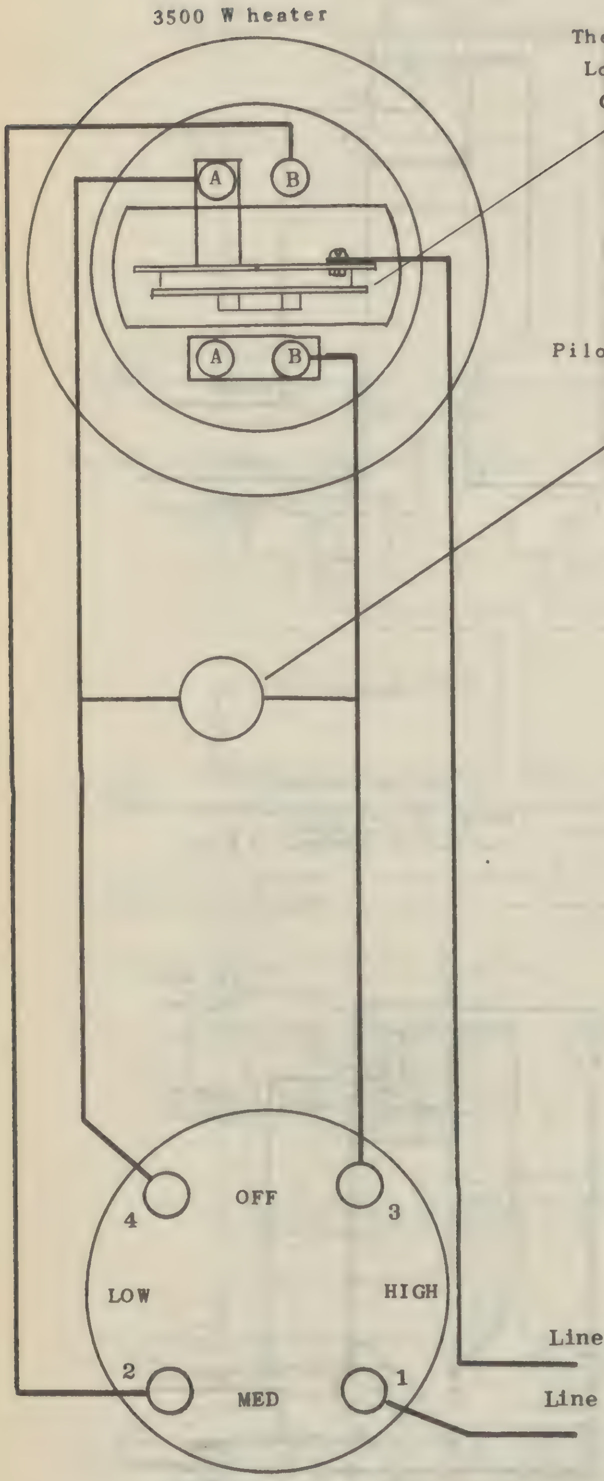
LOW

Two heaters in series
Contact is made between three
Heat switch terminals 1 & 2

ELECTRIC STERILIZER CIRCUITS

WILMOT CASTLE

ELECTRIC CIRCUIT FOR NON PRESSURE STERILIZERS



3 Heat Switch

HIGH

Heaters in Parallel
Contact is made between three Heat switch terminals 1 & 3 2 & 4.

MEDIUM

One heater only
Contact is made between three Heat switch terminals 1 & 3

LOW

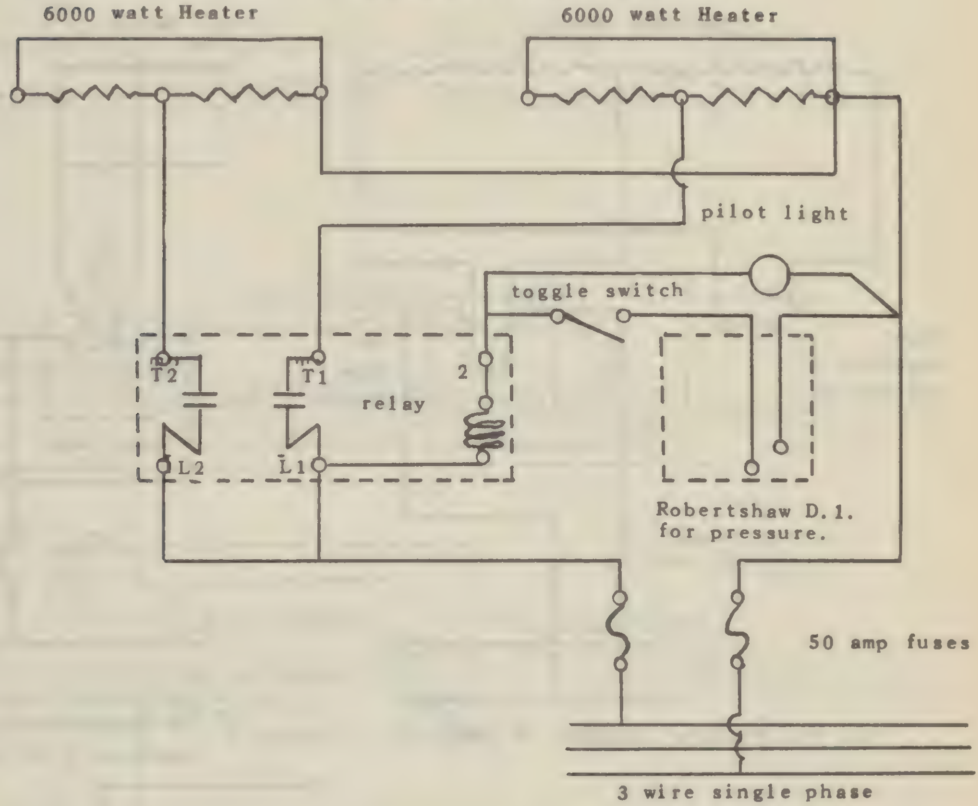
Two heaters in series
Contact is made between three Heat switch terminals 1 & 2.

NOTE

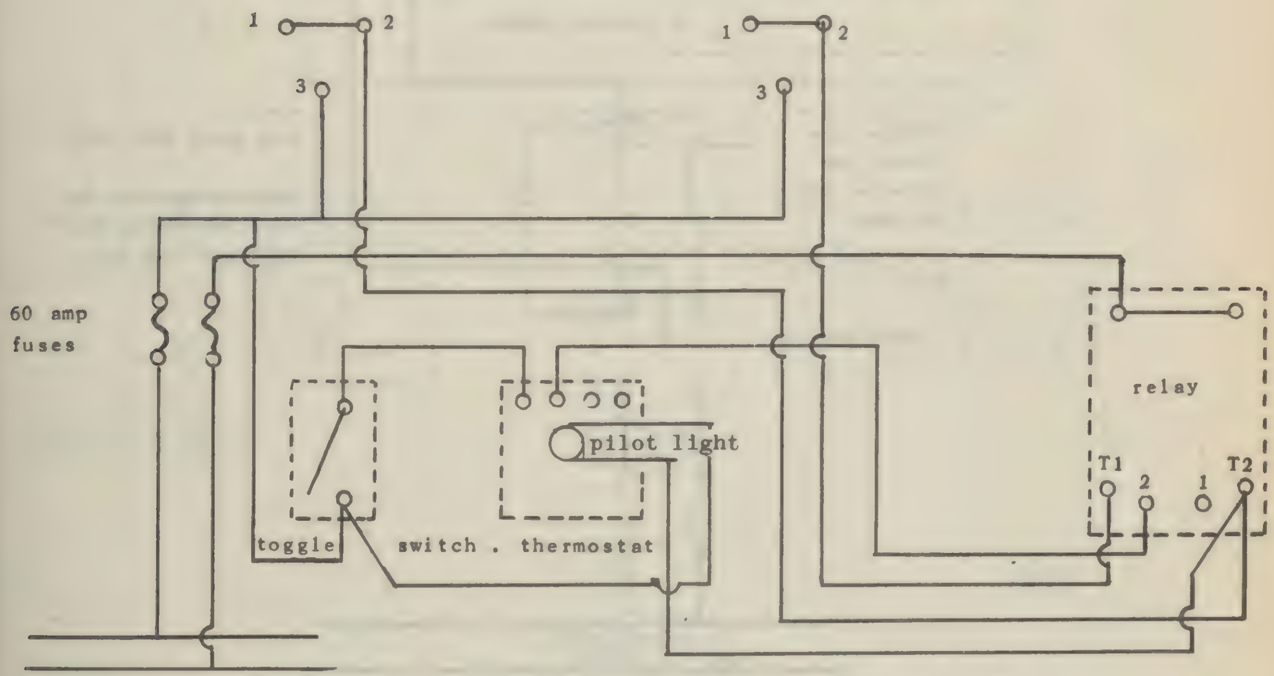
Each complete 3500 W heater unit comprises two independent hairpin shaped heating elements of 1750 W. each. Terminals of each are indicated as A. A. & B. B.

HOSPITAL SUPPLY

ELECTRIC CIRCUIT PRESSURE STERILIZER



CIRCUIT FOR PRESSURE STERILIZERS OVER 6900 WATTS.

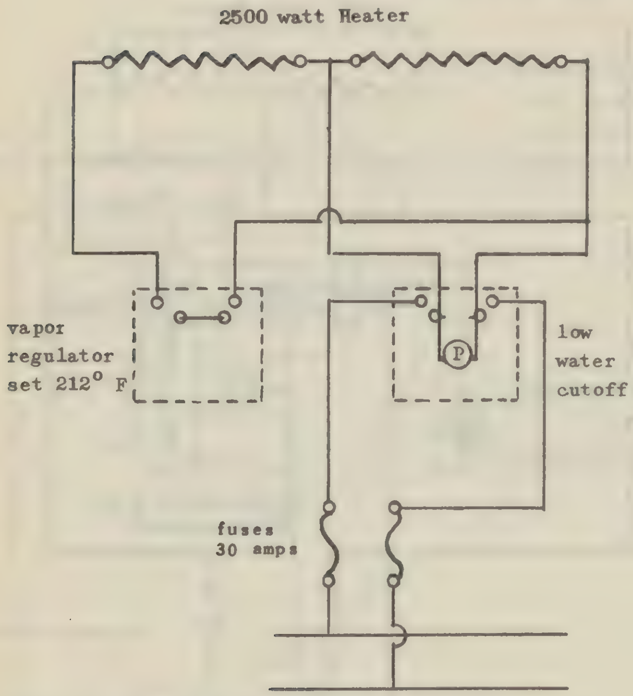


CIRCUIT FOR PRESSURE STERILIZERS . 20X36 U S ARMY.

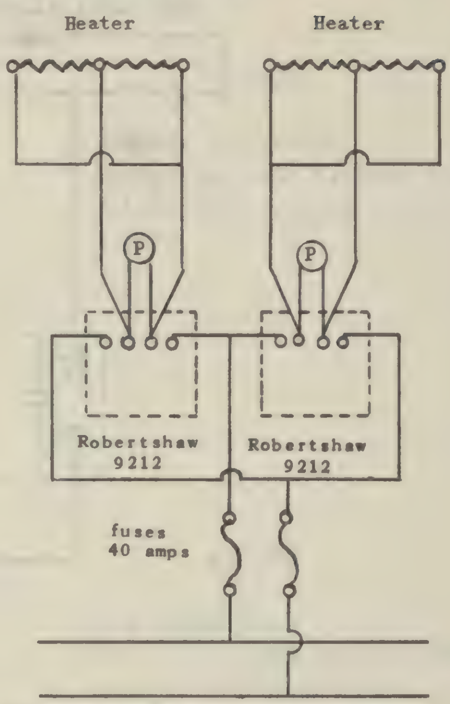
ELECTRIC STERILIZER CIRCUITS

HOSPITAL SUPPLY

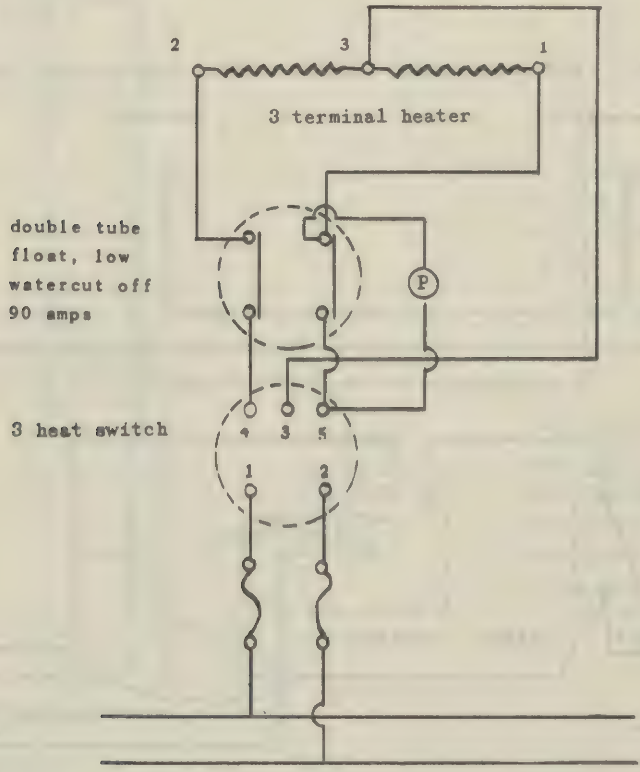
ELECTRIC CIRCUITS FOR NON PRESSURE STERILIZERS



(A) Non Pressure 20X10X9. US ARMY.



(B) Non Pressure with excess vapor regulator & low water cutoff.

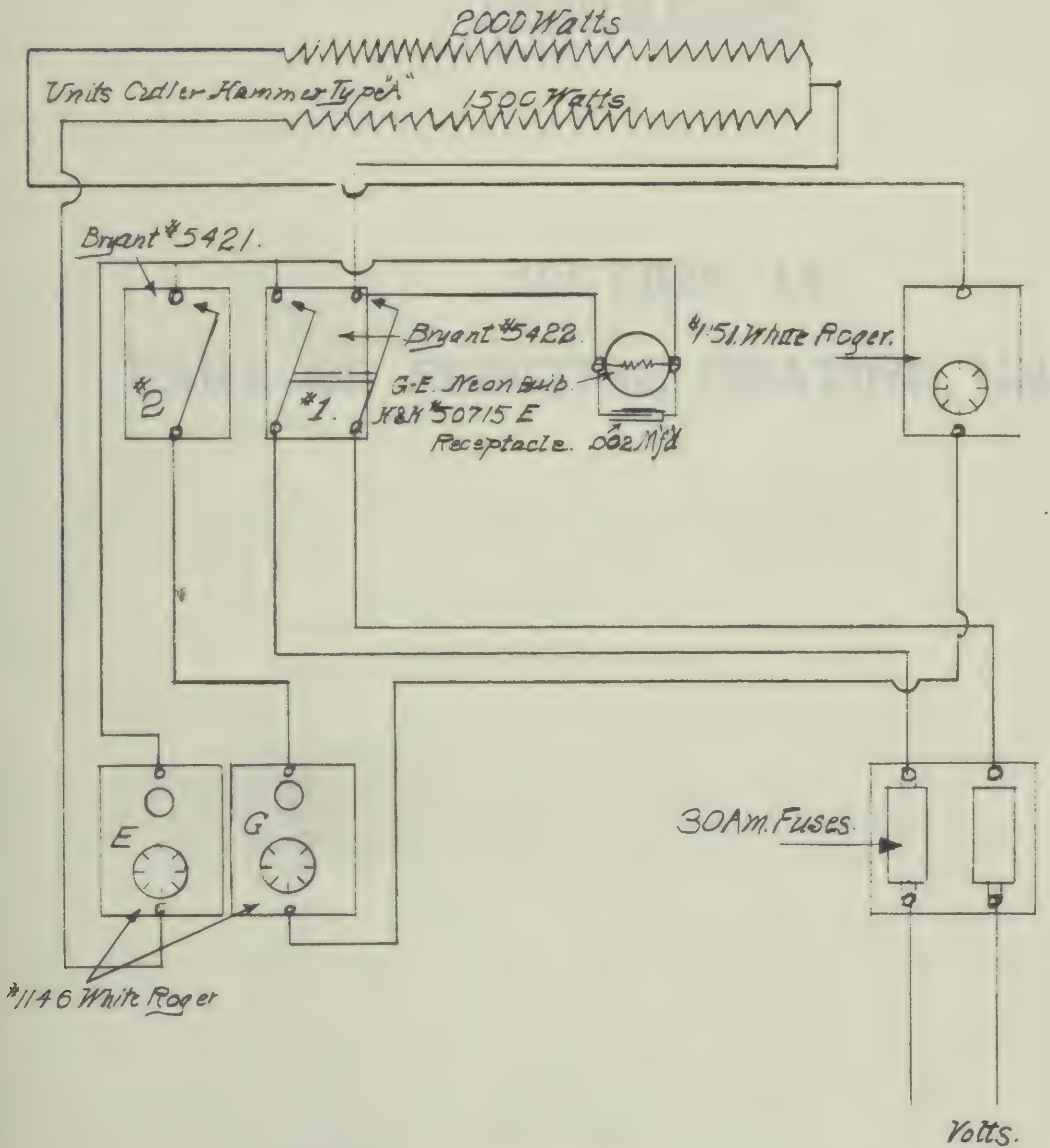


FOR LAND USE ONLY

This wiring only for over 5000 watts 110 V 6000 watt 120 Volts

(C) Non Pressure . 3 Heat switch Control

Schematic Wiring Diagram for
Prometheus 20"X10"X9" Instrument Sterilizer



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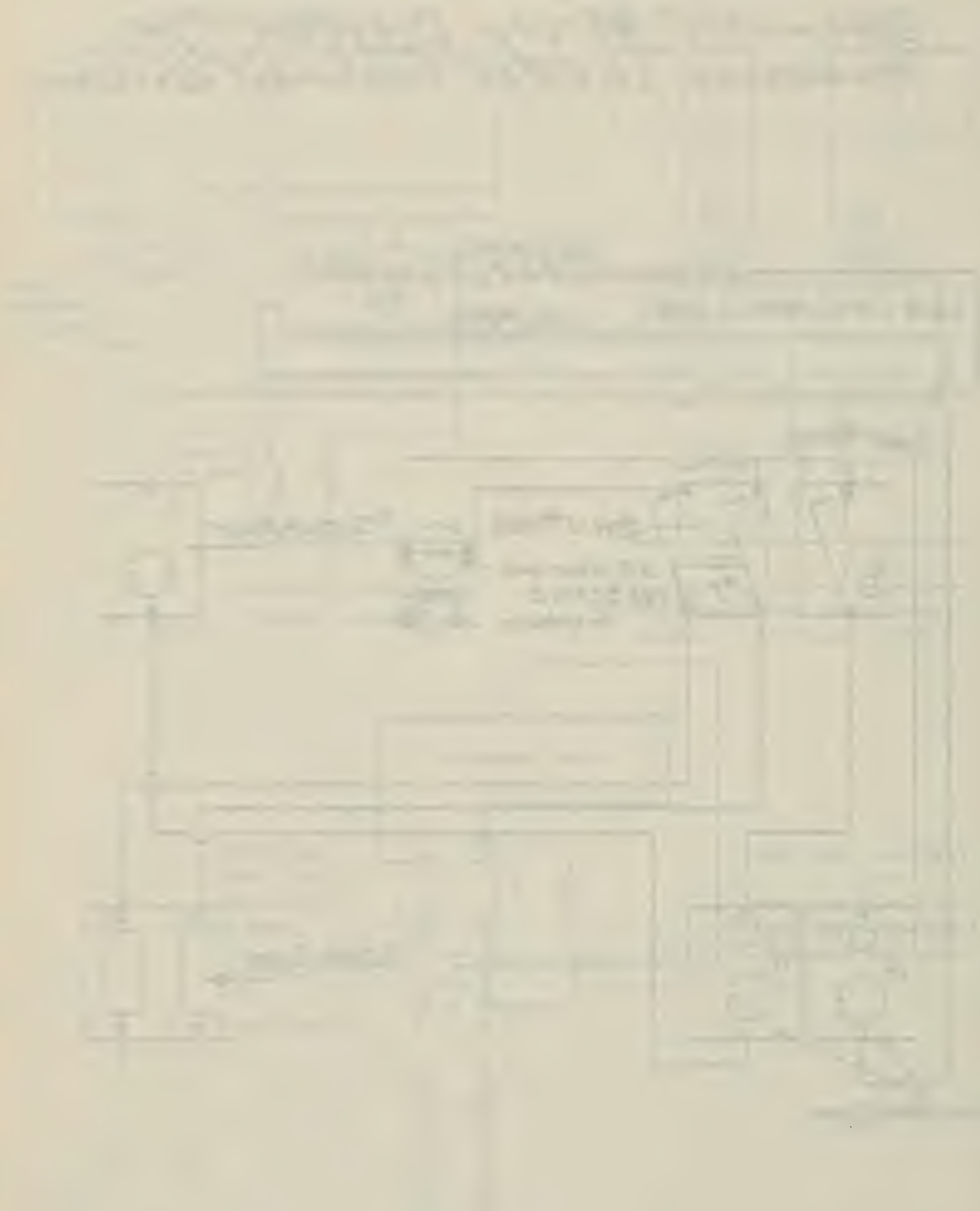


CHAPTER II

STERILIZERS

SECTION 12

CARE OF ELECTRIC HEATING UNITS

CARE OF ELECTRIC HEATING UNITS

Note: These directions are primarily for the mechanic who services or repairs the sterilizers, but they should be carefully read by the persons in charge of the operation of the sterilizers.

THE ELECTRIC HEATING UNITS - Electrically heated sterilizers are heated by heavy duty immersion heating units placed directly in the water in the sterilizer. Each element consists of a spiral shaped coil of high grade nichrome wire securely imbedded in an insulating material and covered and protected by a heavy seamless copper casing. The ends of the heating coil are attached to terminals in each end of the element. These elements are designed for rapid heating of water only. The satisfactory operation of electric sterilizers depends to a large extent upon the heating units being operated under the conditions for which they were designed. The heater head for each sterilizer consists of two or more separate elements rigidly fastened (brazed or sweated) into a mounting plate which can be easily attached or removed from the sterilizer.

REQUIREMENTS FOR SATISFACTORY LIFE OF UNITS - The heating units are designed to operate under the following conditions:

1. Completely covered with water.
2. Free from lime deposit or material which will retard the flow of heat from the element into the water.
3. Line voltage for which they are marked.

Under the above conditions, the heat will be dissipated into the water as fast as it is generated and the unit will not rise above a certain maximum temperature. If these conditions can be maintained the units should last for years. The life of most units is materially shortened by the unfavorable conditions under which they are forced to operate.

NORMAL LIFE OF HEATING UNITS - All materials subjected to heat in time break from the oxidation of the materials of which they are constructed. All heating units will break down from natural wear and oxidation. When this occurs they must be replaced. No definite life of heating units can be given or guaranteed because of the widely varying conditions to which they are subjected. The manufacturers of these units give no guarantee other than a guarantee against defective materials and workmanship, which will show up within thirty days at the most. From then on, the life which may be expected from the units will depend upon the care which they receive from the persons in charge.

CAUSES OF BREAKDOWN OF HEATING UNITS - Outside of mechanical defects or injuries, the main cause of breakdown is overheating. Any condition which prevents the heat from being dissipated from the element as fast as it is generated will cause the heat to accumulate in the unit and result in overheating. The higher the temperature the faster the rate of oxidation and breakdown. A unit at red heat will break down from oxidation within a few hours. In general, the lower the temperature the longe: the life.

Overheating is usually caused by one or more of the following conditions:

1. INSUFFICIENT WATER to cover the unit when it is on. Carelessness on the part of the operator to watch the water level in the sterilizer is usually responsible for this condition which may be caused by:
   A. A leaking water waste valve.
   B. Water boiling away.
   C. Turning current on without any water in the sterilizer.
   D. Draining sterilizer with heat on.

A little care and thoughtfulness can prevent any of these conditions.

2. LIME DEPOSIT - preventing the heat from being dissipated into the water as fast as it generated. The only remedy is the removal of the deposit before it causes damage to the heating units.

3. HIGH VOLTAGE - This cause is not so common but will cause trouble where, for example, a 220 volt element is operated on a line where the voltage runs from 240 to 250 volts. The higher voltage will cause the unit to generate more heat than it can easily dissipate into the water.

PREVENTING BURNOUTS - Regular attention to the condition of electric sterilizers will prevent most of the trouble. We keep our automobiles in condition and save expenses by frequent greasing and checking. The same principle applies.

The following suggestions will help in caring for units:

1. LOW WATER - The operator of the sterilizer should be made to realize that care in watching the water level will prevent trouble from this cause. Always look at the water level before turning on the heat and during the time the heat is on. A frequent source of trouble on autoclaves is failure to close the water waste valve tightly on the generator. If it leaks have a new disk installed- it is cheaper.

2. LIME DEPOSIT - This subject is discussed in more detail in the later sections of these directions. Preventing burnouts from this cause consists primarily in removing the lime from the heating units before it causes trouble.

3. HIGH VOLTAGE - This condition is the responsibility of the local power company. The hospital should have readings made to ascertain if the voltage varies greatly at any time. Sometimes there are periods of the day in which the voltage is much higher than at other times. Heating units are now being supplied for service on 230 volts which meets most conditions. If the voltage reads 240 to 250 volts during the sterilizing periods at the sterilizers with the heaters on, then units rated at 250 volts should be installed. The change has been found advisable and satisfactory at several installations.

THE LOW WATER CUTOUT - All sterilizers are equipped with some form of automatic device for shutting off the current in the heaters should the water level drop too low. Always check these to see they are in operating condition. See further under individual manufacturers data.

LIME DEPOSIT ON HEATING UNITS - The problem of lime deposit depends upon the type of water used in the sterilizers. If surface or softened water is used, there will be little or no lime deposited on the heating units. Occasionally filtered surface water will cause a scale which may have to be removed. The ground or well water is of varying degrees of hardness and chemical characteristics. In the central states, particularly in Indiana, Illinois, Missouri, Iowa and the surrounding states, the ground water contains a large amount of lime and frequently presents a real problem in heating practice. The mechanic or engineer in charge of the sterilizers should be thoroughly familiar with the characteristics of the water used in the sterilizers.

Many institutions have eliminated much of their trouble by the installation of water softeners. In any case it is advisable to fill the sterilizers from the HOT WATER supply. Not only does the hot water reduce the heating time required but reduces the lime which would otherwise be deposited in the sterilizers.

Sometimes the lime deposited is in the form of a hard scale which adheres tenaciously to the heating surface. In other places it forms a light spongy coating which may easily be brushed off. Regardless of the type of deposit it forms a shield which prevents the heat from being rapidly dissipated into the water and must be removed to prevent overheating. The amount of lime deposited will depend also upon the length of time or how frequently the sterilizers are operated. As the dressing and instrument sterilizers are usually used the most frequently, the lime deposit on these units will require the most attention.

INSPECTION OF HEATING UNITS - The most satisfactory method of dealing with lime deposit on heating units is to make periodic inspection of the units and to note the rate of lime deposit. When sterilizers are first installed, a schedule should be made specifying definite dates at which the heating units are to be inspected for lime. Unless the lime content of the water is quite heavy, once every three months should be sufficient. After one or two inspections, it may be found that once or possibly twice a year is sufficient. UNDER NO CIRCUMSTANCES SHOULD LIME DEPOSIT BE ALLOWED TO ACCUMULATE OVER A SIXTEENTH OF AN INCH IN THICKNESS. A record should be kept for each sterilizer showing when the units were cleaned and the amount of lime removed. Regardless of the amount of lime in the water, the elements should be removed and inspected regularly at least once a year. On the pressure sterilizers (water and dressing) the inside of the sterilizer may be cleaned at the same time through the heater opening. Units should also be inspected for signs of corrosion for occasionally there are certain chemicals in the water which may attack the metal sheath and destroy it.

PRECAUTIONS IN REMOVING HEATING UNITS - Some open type instrument and utensil sterilizers may be inspected and cleaned from the inside of the sterilizer by simply removing the tray and draining out the water. On pressure sterilizers (water and dressing) the heater must be removed. BE SURE THE ELECTRICAL CIRCUIT IS DEAD before removing the heater cover. Open the switch on the circuit supplying the sterilizer or pull the plug from the outlet to which the heater is connected.

On sterilizers having the heater assembly on the front of the sterilizer, the entire assembly may be removed as a unit by simply removing the nuts from the bolts which hold it in place. On the older type where the heater is installed by itself, the wiring must be disconnected from the terminals. If any wiring is disconnected be sure to mark or tag all wires and the terminals from which they were removed to prevent mistakes in assembling.

In removing the heater it may be necessary to insert a screwdriver or wedge of some kind between the mounting plate and the casting on the sterilizer so as to break the heater loose. If the gasket splits or tears in removing the head, the old parts should be thoroughly removed from both faces and a new one installed. If possible prevent the gasket from tearing.

DIRECTIONS FOR REMOVAL OF LIME DEPOSIT - Some types of lime deposit may be easily scraped or brushed off with a wire brush. Most lime deposit may be easily removed by dissolving the lime with an acid solution of the following proportions:

1 part of HCI (hydrochloric or muriatic acid)
3 or 4 parts of hot water.

Take the heater outside or to the basement where the acid will not cause any damage and slowly brush the lime with a brush saturated with the acid solution. As the acid attacks the lime it will boil and fume. When it becomes inactive, and stops boiling, put on some fresh acid and continue until the lime has been entirely dissolved.

When clean, wash the unit in fresh water, and neutralize any remaining acid by washing it again with a solution of sodium bicarbonate (common baking soda) followed by a rinse of fresh water.

CAUTION: DO NOT LET ANY ACID OR WATER GET ON THE TERMINALS OR WIRING while cleaning the unit.

If the above method does not remove the deposit, it must be carefully chipped or scraped off. If this is necessary, much care must be exercised to avoid in to the metal sheath of the heating unit.

REPLACING UNITS - If the old gasket is torn or split, a new gasket should be used. A stock of heater gaskets should be kept on hand at all times. If one face of the gasket is coated with a mixture of vaseline and graphite it will prevent the gasket from sticking so tightly to the metal. Replace the bolts or nuts, reconnect the wiring, fill the sterilizer with water, and test for leaks. The first water put into the sterilizer after cleaning should not be used for sterilizing. Bring the sterilizer up to the proper temperature or pressure and again check for leaks while the sterilizer is hot.

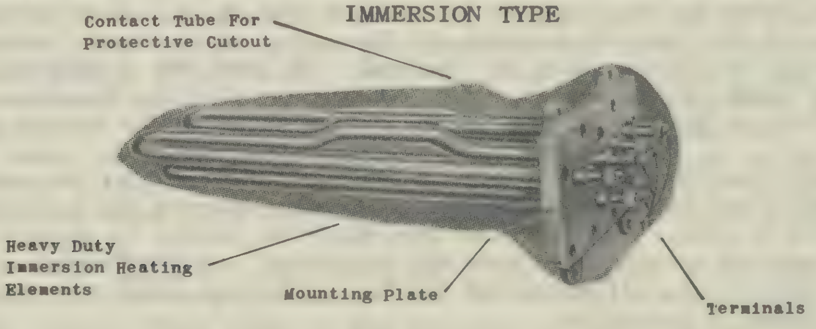
ADJUSTMENT OF LOW WATER CUTOUT - If the sterilizers are equipped with Low Water Cutouts, see separate directions for their care and adjustment.

ORDERING HEATING UNITS - In ordering heating units always specify the following on the purchase order:

Wattage (stamped on heater head) Serial No. (stamped on heater head)
Voltage Size and kind of sterilizer on which it is to be used.

TYPES OF HEATERS USED BOTH ON PRESSURE AND NON-PRESSURE STERILIZERS

IMMERSION TYPE



Heaters Heater Head

CIRCULATING TYPE

Heater Case | Heater Element | Cutoff | Finishing Jacket | Cap

CHAPTER II

STERILIZERS

SECTION 13

COLEMAN GASOLINE STOVE

CHAPTER II

STERILIZERS

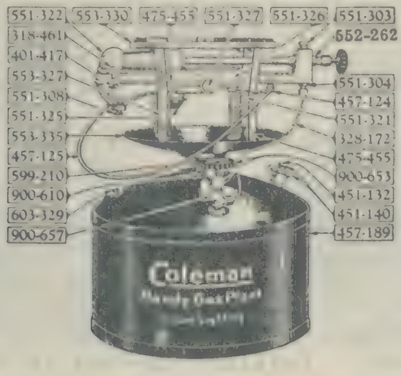
SECTION 13

COLEMAN GASOLINE STOVE

OLD STYLE

DIRECTIONS FOR OPERATING COLEMAN GASOLINE STOVE

FILLING - *CAUTION: Do not fill Tank near an open flame. Always be careful not to spill the fuel.* See that Instant-Gas Valve and Generator Valve are closed. Remove Filler Plug and fill Tank. Use only fresh, clean untreated gasoline. Replace and tighten Filler Plug. Do not use wrench. *NOTE: Always use a good grade of fresh, clean gasoline. Do not use doped, Ethyl, or "anti-knock" gasoline.*



Order By Number	Name of Part
118B620	Valve Stem Packing
308-238	Cleaning Needle and Holder
318-461	R. H. Machine Screw (¼"x1")
325-217	Gas Tip Bushing
325-418	Gas Tip (Marked "4")
328-172	Fuel Tube (12" Long)
401-417	Machine Screw Nut
451-132	Filler Plug Air Stem
451-140	Filler Plug Complete
451-509	Pump Leather
451-522	Jumbo Pump
457-124	Bail Bracket
457-125	Bail
457-189	Tank Complete (457 and 457G)
458-189	Tank Complete (575)
475-455	R. H. Machine Screw (10-24x ⅜")
551-240	Generator Valve Body and Fuel Nipple
551-303	Set Screw
551-304	Feed Wire Nipple
551-308	Drain Plug
551-321	Leg
551-322	Mixing Chamber
551-325	Air Intake Adjuster
551-326	Burner Casting
551-332	Asbestos Gasket
552-212	Generator Tube
552-219	Generator Filler Coil
552-253	Generator Valve Stem (Less Cleaning Needle and Holder)
552-262	Chrome Alloy Generator (Gas Tip Maked "4")
553-327	Grate Bracket
553-330	Grate
553-335	Baffle and Flange Assembled
575-125	Air Gauge
599-210	⅜" Close Nipple
599-250	Bushing (⅜" to ½")
603-329	⅛" I. P. S. Plug
650-136	Filler Plug Gasket
900-118	Fuel Tip (Marked "AX")
900-610	Instant-Gas Valve Safety Lock
900-653	Instant-Gas Valve Stem Complete
900-657	Instant-Gas Valve Complete

COLEMAN GASOLINE STOVE

PUMPING - *CAUTION: Before starting to pump, be sure the Instant-Gas Valve and Generator Valve are closed.* Open Air Stem two full turns to left and place nose of pump in center of Air Stem on Filler Plug. Pump 30 to 40 strokes of air into Tank. Close Air Stem tightly with fingers.

LIGHTING - Check to see that Tank contains sufficient fuel and air. Also that Instant-Gas Valve and Generator Valve are closed. Open Instant-Gas Valve 1/4 turn to the left. (Until Safety Lock stops the valve wheel). Next, open Generator Valve and light Burner. After burning one minute, release safety lock by pressing down and open Instant-Gas Valve as FAR AS POSSIBLE (about three revolutions). *NOTE: If flame is weak, pump additional pressure into Tank. Best results will be obtained if the Generator Valve is not opened wide until the Burner has been burning several minutes.* A yellowish, smoky flame usually denotes liquid gasoline in the burner manifold. If through improper operation or lighting, the burner should become flooded, close Instant-Gas and Generator Valves, and when flame on burner is out, place a receptacle under the Burner Drain (located underneath at rear of Burner) and unscrew Drain Plug. Safely dispose of liquid gasoline drained from burner. Then relight burner as directed. The flame is regulated by the use of the Generator Valve.

SPECIAL LIGHTING INFORMATION - This Coleman Handy Gas Plant is built to accomodate the largest range of usual conditions of any stove on the market at the present time. However, when used in exceptionally cold temperature we recommend the following method of lighting:

Note the small cup built in the front of the burner (located between the burner cap and the generator nipple). When the temperature is unusually cold it will be best to pour a small amount of alcohol or gasoline into this cup and allow it to burn several seconds before attempting to light the burner on the Instant-Gas principle. The reason for doing this is that when lighting by the Instant-Gas method in exceptionally cold temperature the mixture is too lean and the flame will have a

THIS STOVE CAN ONLY BE USED WITH WHITE GASOLINE

tendency to lift off the burner and the burner may not light, but if the few seconds of preheating is used the burner becomes warm enough to compensate for the cold temperature.

This method need only be used in extremely low temperature.

You will also find on lighting the stove when in a semi-hot condition (when stove is relighted before becoming thoroughly cold) that the flame will be yellow when first lighted; however, it will clear in a few seconds and burn blue.

TO TURN BURNER OFF - When you are through using your Burner, close the Instant-Gas Valve by turning wheel to right until closed, then immediately open it one-fourth turn to left, to the Safety Lock. Allow the Burner to burn on the Instant-Gas mixture for about one minute. Now close Instant-Gas Valve by turning wheel to the right and when flame on the Burner is nearly out, close the Generator Valve firmly to the right.

SUGGESTIONS FOR CARE OF COLEMAN GASOLINE STOVE

IF STOVE BURNS WITH YELLOW FLAME - CAUSE: Enlarged opening in Gas Tip. REMEDY: Put in new Gas Tip. CAUSE: Cleaning Needle on end of Generator Valve Stem bent. REMEDY: Remove Valve Stem and straighten needle or replace with new needle. CAUSE: Raw gasoline in burner manifold. REMEDY: Drain burner manifold as per "Lighting" directions.

IF GASOLINE LEAKS DEVELOP - At Instant-Gas Valve or Generator Valve--Tighten packnut just enough to stop leak. *DO NOT TIGHTEN WHEN STOVE IS BURNING*. At Gas Tip--Tighten gas tip bushing.

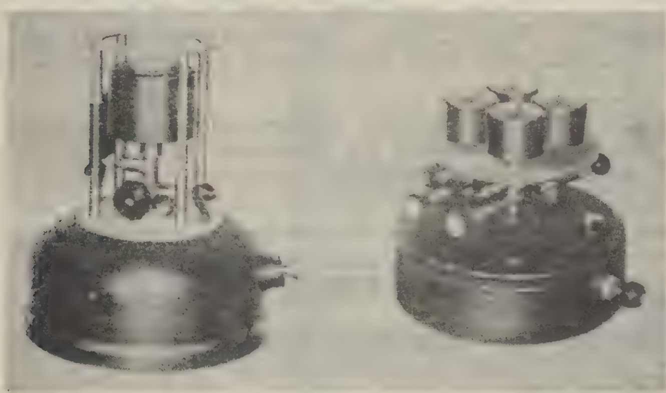
IF PUMP DOES NOT WORK - CAUSE: Air Stem not open. REMEDY: See that filler plug air stem is unscrewed two full turns to left. CAUSE: Pump leather may be dry. REMEDY: Remove pump plunger and soften leather with a few drops of oil. CAUSE: Leather worn out. REMEDY: Put on new leather. See "Pumping" directions.

IF BURNER DOES NOT LIGHT OR FLAME IS WEAK - CAUSE: No fuel or lack of air pressure. REMEDY: See that tank contains clean gasoline, then pump up to operating pressure. CAUSE: Dirty Burner Cap. REMEDY: Remove Generator and clean slots in burner casting with a piece of thin sheet metal. Replace Generator. CAUSE: Gas tip stopped up. REMEDY: Close Instant-Gas Valve, then open and close Generator Valve several times, thus working needle through gas tip orifice to remove obstruction. CAUSE: Generator tube may be stopped up with dirt or carbon. REMEDY: Disassemble generator and clean, or take to your nearest Coleman Dealer who is equipped to service the generator for a reasonable charge.

If water or dirt gets mixed with gasoline, remove filler plug, releasing air pressure. Remove 1/8" I.P.S. plug and pour all old gasoline from tank. After all old gasoline has been removed from tank, rinse tank out with clean fuel. Repeat this operation until you are sure tank is clean. Replace the 1/8" I.P.S. plug, then fill and pump to correct operating pressure.

OPERATION AND MAINTENANCE COLEMAN MILITARY HEATING UNITS
(New Style for Use With Leaded Gasoline)

To successfully use a mechanical appliance of any type, it is necessary to understand the basic principles of its operation. Coleman Military Heating units are designed to convert gasoline (motor fuel) to a dry gas which, with the proper mixture of air, will produce a clean, hot flame on the burner.

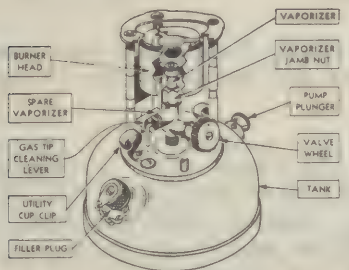


Conversion of liquid gasoline to a dry gas is accomplished through a vaporizing process. To vaporize gasoline, Coleman Burners first atomize (spray) the gas for instant lighting and then, through application of heat, complete vaporization into a dry gas.

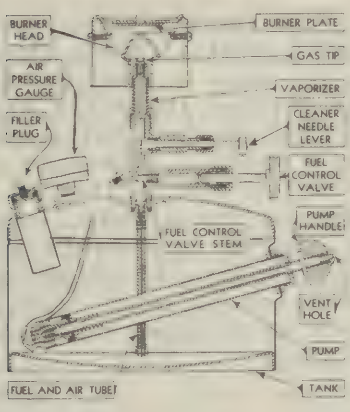
Coleman Military Heating Units are equipped with either 5,000 or 10,000 B.T.U. burners. Several burners are mounted on the same tank to produce units of greater than 10,000 B.T.U. heating capacity.

Models using 5,000 B.T.U. burners 520-521-523-526

burners 522-524-525



TYPICAL OF 5,000 B.T.U. UNITS
Models 520, 521, 523, 526



TYPICAL OF 10,000 B.T.U. UNITS
Models 522, 524, 525

TO FILL - Be sure Fuel Valves are tightly closed. Turn the Valve Wheel to the right.

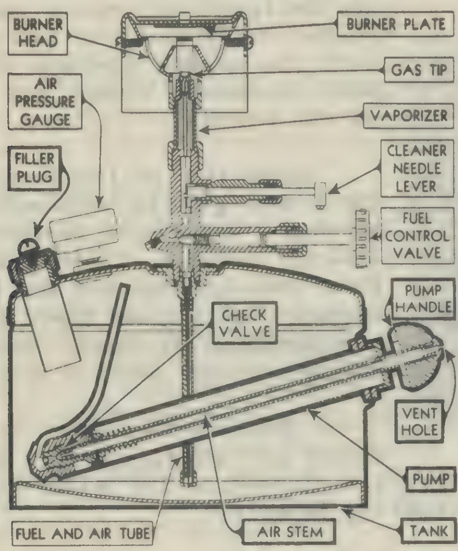
Fill Tank with fresh clean gasoline. We suggest the use of a strainer funnel in filling Tank. For maximum efficiency and vaporizer life, use clean non-leaded gasoline. If non-leaded gas is not available, leaded gas may be used, provided adequate ventilation is provided for when operated in confined spaced.

Replace Filler Plug Cap and tighten firmly with fingers.

TO PUMP AIR PRESSURE - See that Fuel Valves are closed, then turn Pump Handle to left two turns. Hold thumb or palm of hand over Vent Hole in end of Pump Handle and pump 30 to 35 full strokes of air into the Tank. Turn Pump Handle to right to close. Additional pressure should be added later while burners are generating. Keep Pump Leather soft with a few drops of oil.

TO LIGHT EACH BURNER - Clean Gas Tip in Vaporizer by revolving, several times,

Open Fuel Control Valve a quarter turn to left. After a few seconds apply lighted match at top of Burner Head. In extremely low temperatures allow Burner Head to become moist with gasoline before applying lighted match. 5 to 10 minutes are required for complete generation. Under some conditions flame may blow itself out. Just relight. Flame will soon settle down to steady blue.



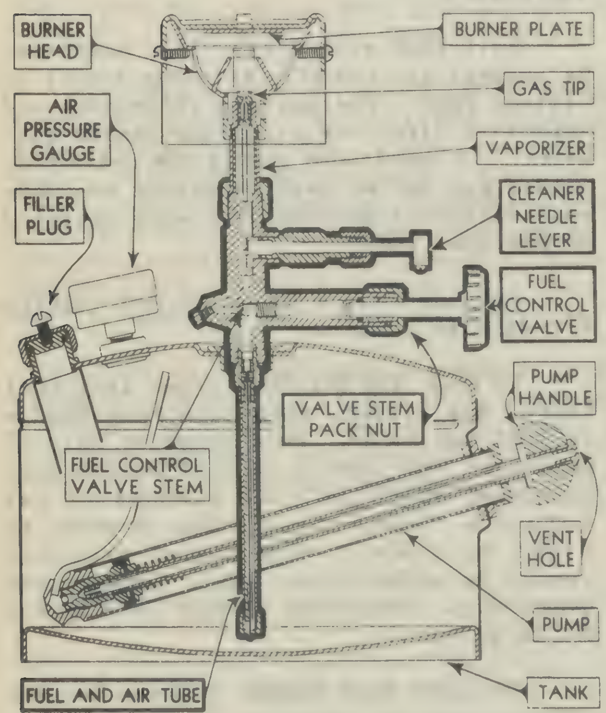
Several strokes of the Pump must be added to replace air used in generation.

After flame burns steady blue for 2 or 3 minutes, open Fuel Control Valve AS FAR AS POSSIBLE.

TO SHUT OFF BURNER - Close Fuel Control Valves.

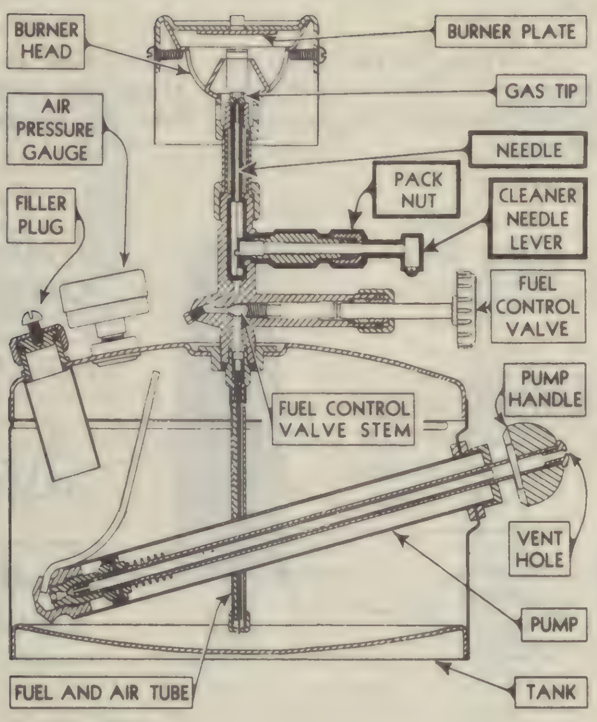
FOUNT AND PUMP ASSEMBLY - Examine Filler Plug Gasket at intervals and replace if it is cracked or worn. Pump Plunger should be removed occasionally and a few drops of lubricating oil worked into the Pump Leather to maintain peak efficiency.

IMPORTANT - *Empty Tank frequently and rinse with fresh gasoline to remove any accumulation of water and*



If Check Ball Sticks, remove Check Valve and Clean or, if necessary, replace with new one. Replace Air Stem and Check Valve, if threads will not hold when Pump is turned to *OFF* position.

FUEL VALVE - Valve Stem Packing will usually shrink after appliance has been in use, resulting in a gas leak at the Valve Stem Pack Nut. Tighten Pack Nut a few turns to hold packing firmly in contact with Valve Stem. If Pack Nut is tightened too firmly, the Valve Stem will be difficult to turn. Back Pack Nut off slightly. Replace packing when leak can no longer be stopped by tightening Pack Nut.



TIP CLEANER ASSEMBLY - This mechanism operates the Tip Cleaning Needle in the Vaporizer. The Tip Cleaning Lever should be revolved several turns before lighting the burner and at frequent intervals during its operation to prevent Vaporizer Tip stoppage. If a leak develops at Pack Nut, tighten Nut a few turns until leak stops. Replace packing if leak cannot be stopped by tightening Pack Nut.

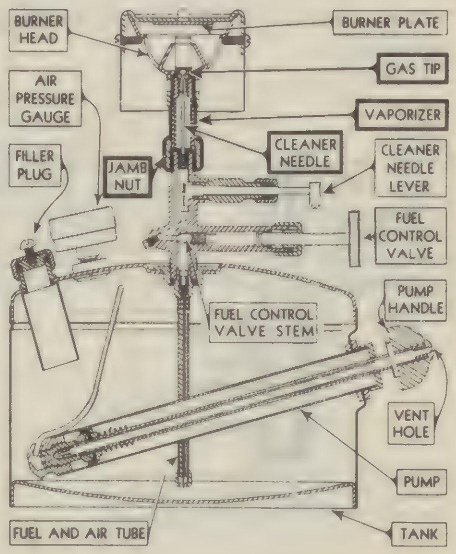
VAPORIZER ASSEMBLY - When hydro-carbon fuel (gasoline) is vaporized and burned, a residue in the form of carbon is produced from the gum content of the fuel.

If anti-knock compounds are added to gasoline to improve the operating efficiency of motorized equipment, the resulting fuel will, when used in gasoline pressure appliances, form a residue of both carbon and lead in the Vaporizer. It can be readily understood, therefore, that anti-knock compounds added to gasoline containing gum will form varying amounts of residue in direct proportion to the gum content and the amount of anti-knock compounds added.

When Burners are kept in continuous operation from fifteen to twenty hours daily, using fuel having a heavy gum content and high percentage of lead, naturally, it will be necessary to clean or replace Vaporizers every two to five days.

Vaporizers on Burners used only a few hours daily will require cleaning or replacement *only at intervals of a month to six weeks.*

When anti-knock gasoline is used, the average time a Vaporizer can be used without cleaning or replacement is fifty to one hundred hours--depending on gum and lead content of the



fuel. The use of Regular (unleaded) gasoline having a normal gum content, will substantially increase vaporizer life.

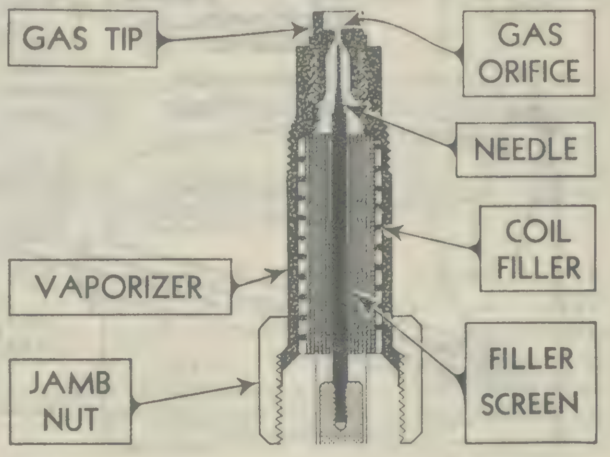
As an accumulation of residue is built up in the Vaporizer Tube, flame strength on the Burner will be noticeably decreased. When an efficient flame can no longer be maintained, it is usually an indication that the Vaporizer Tube is clogged and requires either cleaning or replacement.

TO REMOVE VAPORIZER - Remove Burner Head by unscrewing to the left.

Take off Jamb Nut at the base of Vaporizer--hold Valve Body so that it will not be loosened in Tank.

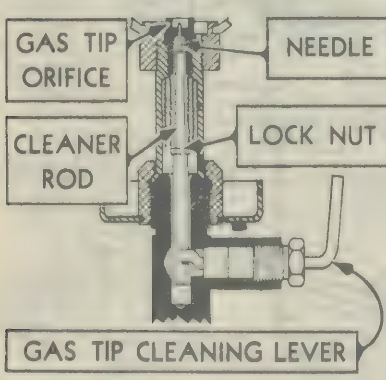
Lift Vaporizer Tube straight up with care to avoid damage to Needle Assembly.

Unscrew Needle Lock Nut on Models Nos. 520, 521, 523, 526. On Models Nos. 522, 524, 525, the Needle is screwed directly into the Eccentric Block, without Lock Nut.



TO CLEAN VAPORIZER - Remove Filler Screen and scrape all carbon from inside of Vaporizer. Do not force anything through gas tip hole, as this would increase size of opening. If a new Filler Screen is available, insert in Vaporizer Tube; however, old screen may be cleaned and reused if care is taken in unrolling and re-rolling. Screen must be rolled tightly around Cleaner Rod before being put back into Vaporizer to insure proper lighting.

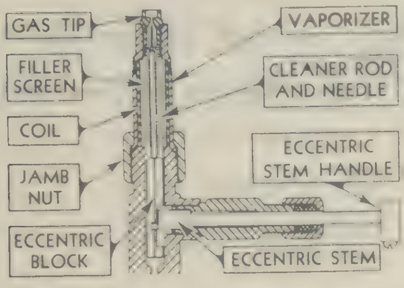
Care must be taken not to damage the needle when reassembling Vaporizer over the needle.



NOTE - Before reinstalling the Vaporizer, test operation of Fuel Valve by opening Valve, one-fourth turn (lighting position), to determine if Valve is unclogged and gasoline sprays freely. If gas does not spray freely, it is an indication that the Valve should be removed and cleaned, or replaced with a new one, if cleaning is not practical.

TO REPLACE VAPORIZER - On Models 520, 521, 523, 526; turn Tip Cleaner Lever up and loosen Lock Nut at base of Cleaner Rod, then unscrew rod to left. The new Cleaner Rod and Needle can now be put in and adjusted to the proper length. Be sure and lock in place after adjustment is made by using Lock Nut from old Needle. When Tip Cleaner Lever is turned up, the Needle should come through the

Gas Tip Orifice about 1/32" but should not extend above the top of Gas Tip. Do not try to service a bent or otherwise damaged needle.



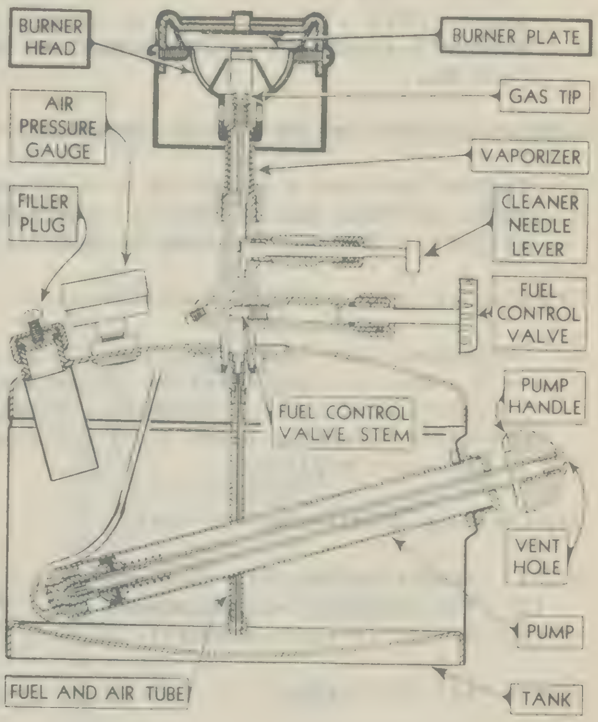
On Models 522, 524, 525, which use the Needle, less Lock Nut, screw the Needle firmly into the Eccentric Block. Replace Vaporizer Tube and Filler Screen over Needle and tighten firmly on Valve Body with Vaporizer Jamb Nut. Replace Burner Head and tighten firmly on Vaporizer.

BURNER HEAD - Vaporization of the gas delivered through the Vaporizer Tube is completed when the gas stream strikes the Burner Plate in the center of the Burner Head. When leaded fuel is used, particles of the anti-knock compounds are deposited on the underneath side of Burner Plate. To maintain operating efficiency, this residue must be cleaned frequently, or, every few days. *NOTE - Clean every 15 to 20 hours when fuel having heavy lead lead content is used.*

TO CLEAN BURNER PLATES - Unscrew and remove the Burner Head.

Insert a sharp stick or wire through the hole in the bottom of the Burner Head to clean or scrape carbon accumulation off the underside of the burner plate.

Replace and tighten firmly on the Vaporizer.



SERVICE QUESTIONS AND ANSWERS

Q. Pump does not operate properly.

A. (1) Before attempting to apply pressure to the Tank, open Pump Assembly by turning a few turns to the left. Hold thumb or palm of hand *over vent hole* in end of Pump Plunger.
(2) Pump Leather dried out. Remove Pump Plunger and work lubricating oil into leather, or, replace if leather is worn out.
(3) Check Ball stuck. Remove Check Valve and clean. Replace if Check Ball does not work freely after cleaning.

Q. Will not hold air when Pump Plunger is in OFF position.

A. Threads on Air Stem and Check Valve worn out. Replace.

Q. Leaks around Filler Plug.

A. Filler Plug Gasket damaged or worn out. Replace.

Q. Leak at Valve Stem Pack Nut.

A. Tighten Pack Nut a few turns to hold packing in firm contact with Valve Stem. NOTE - If Pack Nut is drawn up too tightly, Valve will not turn. Back off slightly. Replace packing if leak is not stopped by tightening Pack Nut.

Q. Leak at Pack Nut on Tip Cleaner Assembly.

A. Tighten Pack Nut a few turns to hold packing in firm contact with Valve Stem. NOTE - If Pack Nut is drawn up too tightly, lever will not turn. Back off slightly. Replace packing if leak is not stopped by tightening Pack Nut.

Q. Tip Cleaner Lever will not turn.

A. Continuous use of fuel having a high gum and anti-knock compound content will cause an accumulation of carbon on Eccentric Block. causing it to "freeze" in the valve assembly. Models Nos. 522, 524, 525, have an easily removable Eccentric Block and Tip Cleaning mechanism. Remove and clean, or, if necessary replace.

Q. Tip Cleaning Needle does not work.

A. (1) Needle broken off. Replace.
(2) Tip Cleaning mechanism worn out. Replace.
(3) Needle loose in Eccentric Block. Tighten.

Q. Burner will not light.

A. (1) Out of fuel.
(2) Not enough pressure in Tank.
(3) Vaporizer Tip clogged. Revolve Tip Cleaner Lever several turns. Be sure Cleaning Lever is in DOWN position when lighting burner.
(4) Vaporizer clogged. Clean or replace.
(5) If burner does not light after checking above suggestions, the valve complete should be removed and inspected. Clean tip on end of Fuel and Air Wire. Replace Valve if gum has clogged Valve Body.

A. Burner burns but produces "red, lazy" flame.

A. (1) Tank pressure too low. Pump several additional strokes.
(2) Vaporizer Needle bent. Replace.
(3) Vaporizer almost clogged. Clean as above, or replace.
(4) Burner Plate corroded. Unscrew and remove Burner Head. Insert a sharp stick or wire through the hole in the bottom of Burner Head to clean or scrape carbon accumulation off the underside of the Burner Plate. Replace and tighten firmly on the Vaporizer.

IT IS IMPORTANT that the underside of burner plates be cleaned frequently or every few days. Failure to do this regularly will reduce the efficiency of the burners.

(5) Burner loose on Vaporizer. Tighten.

Q. Burner backfires or burns with red flashes.

A. (1) Burner loose on Vaporizer. Tighten.
(2) Burner Plate corroded. Clean as above.

DRAIN THE TANK - Before the Burner is stored away; or, if water accumulates in the Tank.

On models which have a Pressure Gauge, remove Gauge and pour contents out of the Tank thru Gauge outlet.

On models not equipped with Pressure Gauge—remove Burner and Valve and pour contents out thru the Valve opening, or let Burner burn out of Fuel.

Part. No.	Description	Model Nos. on Which Used
104 - 136	Filler Plug Gasket	523
118 B 136	Filler Plug Gasket	520, 522
118 B 620	Packing	520, 521, 523, 526
216 - 509	Pump Leather	520, 521, 522, 523, 525, 526
216 - 532	Pump Air Stem	523
216 - 538	Check Valve Assembly	522, 523, 524, 525
216 - 620	Eccentric Stem Packing	522, 524, 525
242 B 532	Pump Air Stem	521, 526
242 B 538	Check Valve Assembly	520, 521, 526
390 - 532	Pump Air Stem	524, 525
451 - 140	Filler Plug	522-375S (American Sterilizer)
451 - 509	Pump Leather	522-375S (American Sterilizer)
451 - 522	Pump	522-375S (American Sterilizer)
520 - 140	Filler Plug	521, 526
520 - 259	Filler Screen	520, 521, 523, 526
520 - 299	Vaporizer	520, 521, 523, 526
520 - 375S	Burner Head	520, 521, 523, 526
520 - 657	Fuel Valve Complete	520, 521, 523
520 - 950	Wrench	520, 521, 523, 526
522 - 140	Filler Plug	522
522 - 251	Cleaner Rod and Needle	522, 524, 525
522 - 260	Coil and Screen	522, 524, 525
522 - 299	Vaporizer	522, 524, 525
522 - 373S	Burner Head Complete	522, 524, 525 (American Sterilizer)
522 - 532	Pump Air Stem	522
522 - 657	Fuel Valve Complete	522, 524, 525
522 - 950	Wrench	522, 524, 525
523 - 140	Filler Plug	523
524 - 520	Pump Plunger	524, 525
575 - 125	Air Pressure Gauge	522, 524, 525
603 - 136	Filler Plug Gasket	521, 526
650 - 136	Filler Plug Gasket	524, 525
650 - 140	Filler Plug	524, 525
701 - 220	Valve Stem Packing	522, 524, 526

CHAPTER II

STERILIZERS

SECTION 14

TROUBLE SHOOTING ON STERILIZERS

TROUBLE SHOOTING ON STERILIZERS

STEAM SUPPLY AND RETURN LINES

FAULTY CONTROL VALVES - See sections dealing with various makes of sterilizers, individually.

FAULTY STEAM TRAPS - There are two types of Traps used on sterilizers, Thermal or Expansion Type and Bucket or Float Type.

Thermal or expansion type Trap: (This type used most generally). This type contains an expansion element which automatically expands when a certain predetermined temperature is reached to close off the exhaust port to the return. As condensation collects, the temperature drops, the element contracts and opens the port allowing low temperature air or condensation to pass into the return line until a higher temperature again closes the trap.

Bucket or float Trap: (Mostly used for bleeding steam supply line, etc.). This type has a chamber containing a float. When the chamber is empty or partially full, the float is down and closes the exhaust port. As the chamber fills to a certain level, the float rises causing the exhaust port to open and the pressure in the trap forces out the condensation through the exhaust port until the float falls to a certain level. Some traps combine a thermal port with a float for bypassing air and low temperature steam until sufficient condensation accumulates to operate the float chamber.

EXTERNAL EVIDENCE THAT A TRAP IS NOT WORKING - Two things can happen to a steam return Trap: first, the Trap may become plugged and not allow anything to pass through the exhaust port to the return; second, the Trap may fail to close and allow steam to pass continuously. If the Trap fails to open, water will collect in the heated chamber or Coil and finally may stop heating. The presence of water is indicated in an Autoclave by pounding and hammering when the steam is turned on. If the Trap fails to close, it may be difficult to maintain pressure in the sterilizer and the return line will become excessively hot. If the return line is broken at the union between the Trap and the return, the action of the Trap may be observed as it discharges the condensate.

HOW SHOULD A GOOD TRAP OPERATE WHEN DISCONNECTED FROM THE RETURN LINE? When the steam is first turned on, there should be a rush of cold air, then hot air and steam, and condensate all under pressure until the Trap (thermal type) closes. Then the Trap should open intermittently to discharge condensation and a little steam with it. There may also be a constant drip from certain kinds of Traps, rather than a complete shut-off.

WHAT IS THE RESULT FROM HAVING STEAM BACK PRESSURE ON THE RETURN LINE? The back pressure may prematurely close the return Trap and prevent it from discharging the condensation into the return line; if the pressure is great enough, it may even prevent the discharge of condensate at all, even though the Trap may be open. No Trap will function properly on a return line having any appreciable amount of back pressure on it.

PRESSURE STEAM RETURNS - A steam heated sterilizer cannot be connected to a return on which other pieces of equipment NOT equipped with individual Traps are connected. The steam from the other equipment will prevent the Trap on the sterilizer from working properly. Neither should a return line having a common Trap in the basement be used as there may be pressure on the line at other points between the Trap and the equipment. If a new sterilizer having an individual Trap has to be piped into a set of sterilizers of the old type having only one common Trap, the return from the new sterilizer must be tied into the return on the non-pressure side of the common Trap, that is between the trap and the receiving Tank. If this is not

possible, the return may be discharged into a waste line through an open fitting.

ELECTRIC STERILIZERS

ADJUSTMENT OF PRESSURE - Is accomplished by varying the pressure exerted by the spring on the expansion bellows of the automatic electric regulator, etc. See separate instructions for the various makes of sterilizers.

DEFECTIVE MERCURY SWITCHES OR TUBES - A perfect mercury tube is clear and bright, the mercury moves fast and clean. A defective tube is gray and cloudy.

LIME ON HEATING UNITS - This condition may cause many symptoms of trouble. Lime deposits act as an insulating medium between the heater and the water thus slowing down the heating of the sterilizer. When heavy, it may in some cases cause Low Water Cut Off to shut off prematurely due to the excessive temperature of heating elements (because heat is not conducted away from the element as fast as it is generated). Certain electrically heated sterilizers will hammer or pound if the heating units become badly limed up. In such cases dismantle heating units, take apart and clean off lime. Soft lime deposits may be removed by scraping away with a knife or stiff brush. Hard deposits may be dissolved by a solution of one part hydrochloric acid to three parts of hot water. When through neutralize acid by rinsing with a strong solution of bicarbonate of soda (ordinary cooking soda). Be careful acid solution does not come in contact with plated parts.

For further data on electrically heated sterilizers, see sections dealing with various makes of sterilizers, individually.

AUTOCLAVES

PLUGGED UP SCREEN IN CHAMBER DRAIN - If this Screen becomes filled, condensation cannot get out of Chamber with result that dressings will be wet, water will collect in the Chamber, and Thermometer will show too low a temperature--This Screen should be kept clean.

FLUCTUATING STEAM PRESSURE - With a wide variation of pressure it is practically impossible to set the Control Valve for a constant operation. At high pressure the Safety Valve will blow and at low pressure the goods may not be sterile. A variation of 20# is the maximum allowed for efficient operation of a standard steam heated sterilizer. A wide variation can be corrected by installing a line reducing valve on the steam supply line.

INCORRECT PRESSURE GAUGES - When there is no Pressure or Vacuum on the sterilizer, the pointer should be at the zero mark. Some of the Newer Gauges have an external adjusting screw, either on the back of the case or in the dial under the glass, by which the pointer may be turned to zero. See also instructions how to set gauges as listed under service data of individual manufacturers.

LACK OF VACUUM ON VACUUM TYPE AUTOCLAVES - This may be caused by dirt in the Ejector, the Check Valve or the Air and Condensation Exhaust Line not closing. Clean thoroughly or replace. Insufficient steam pressure 18-20# min. in Jacket (in case of steam-operated Ejector) or insufficient water pressure 40#(in case of water-operated Ejector) probably leaking door Gasket. Tighten door or install new Gasket.

LOW TEMPERATURE READING ON THERMOMETER - Assuming there is adequate pressure in the Jacket, the trouble would be caused by an obstruction in the Air and Condensate Exhaust Line. Check the Strainer in the chamber drain outlet, it may be plugged. Examine the Check Valve, it may be stuck, the Trap may be over expanded, or dirt in bottom of Trap. If line becomes plugged by glucose or some similar sub-

stance, the line may be cleaned out by inserting a funnel in the Chamber Drain Outlet and pour in one or two liters of boiling hot tri-sodium-phosphate solution as fast as the fluid will flow through. Make solution strong.

NOISE ON STEAM-HEATED AUTOCLAVES - This would be caused by water in the steam supply line, or water in the Jacket which has not been removed through the steam return line. This can be eliminated by properly bleeding the steam supply line through a trap to the return line to return the condensate to the boiler without letting it enter the sterilizer, or by seeing that the return line is free of pressure and open to the receiving Tank. Back pressure against the steam Trap will cause it to close prematurely and prevent condensation in the Jacket from being released, thus retaining water in Jacket.

SOLUTIONS BOILING OVER - Lowering the pressure in the Chamber faster than the temperature of the solution goes down. This would be caused by opening the chamber vent valve after sterilization, the sudden lowering of the pressure causing ebullition. After the solutions are sterilized, the autoclave should be allowed to cool without venting the chamber.

STICKING DOOR - If a door sticks to a new Gasket, it can be opened as follows: Loosen the hand wheel a small amount so that the fingers are just loose, but are still under the door collar. Then slightly open "steam to chamber" valve, allowing two or three pounds pressure to form in Chamber. This will be sufficient to push open door. Powdered graphite on the face of the Gasket will prevent it sticking to door. If it is desired to make a paste of the graphite, use water, never use oil.

WATER DISAPPEARING FROM GENERATOR (OR SUB BOILER) - Caused by excessively high pressure on Steam Coil and too small connections between the Generator and Jacket which together cause violent boiling and the water to be carried up into the Jacket with the steam. A maximum of 50 pounds pressure will remedy this condition. A leaking waste valve on generator would also be a cause. Either shut valve tight or, if necessary, replace disc.

WATER RISING IN GENERATOR - Caused by a leaking water supply valve. Either shut valve tightly, or if necessary replace disc.

WET DRESSINGS

a. Caused by a plugged Screen in Chamber Drain, a stuck Check Valve, or defective trap on Air and Condensation Exhaust Line or any obstruction in this line which prevents escape of condensation.
b. A Jacket full of water due to a faulty steam return line.
c. An abnormally wet steam supply to Autoclave due to too small a steam supply line from the boiler.
d. Improper bleeding to the return for removal of condensation.
e. Poor insulation in cool places causing excessive condensation in the line.
f. Long horizontal runs.
g. Operator using incorrect technique to sterilizing procedure. Read directions for operation.

WATER STERILIZERS

PLUGGING OF COOLING COILS - When water is raised above 160° F. in temperature, the mineral salts such as lime are left on the heating surfaces. When cooling water is turned into a Cooling Coil, it is heated enough to cause lime to be deposited on the inner surface of the Cooling Coil (assuming hard water is used for

cooling). If this is not removed occasionally, the Coil may eventually become entirely closed. If the Coil is not entirely plugged up, that is, if there is any opening at all, a strong solution of muriatic acid (one part acid to three parts hot water) may be slowly poured through the Coil until the lime is all dissolved. When through, rinse Coil with a solution of bicarbonate of soda (cooking soda) to neutralize any remaining acid. If there is no opening at all and nothing can be forced through, a new Coil must be installed.

SAFETY VALVES BLOWING CONTINUALLY - This is generally caused by failure of the Control Valve to close properly allowing steam to pass, even when it is in the closed position. Sometimes dirt or a piece of pipe scale keeps the Control Valve from closing. Again the seat or disc is worn and needs replacing.

SLOW HEATING - Caused by lime accumulating on steam coils, on electric heaters and on the interior of the generator. Too low a pressure on the steam supply, back pressure on the return line causing trap to close prematurely.

CHAPTER II

STERILIZERS

SECTION 15

SPECIAL PARTS SECTION
- AMERICAN STERILIZER -

SPECIAL PARTS SECTION

AMERICAN STERILIZER AUTOCLAVE DOOR

1. Forged steel clutch piece secured to hex steel rod which passes freely through hex hole in hand wheel collar causing it to turn inflexibly with hand wheel.

2. Forged steel clutch piece--companion piece to (1) is rigidly secured to door.

3. Allegheny metal diaphragm, 5-1/8" diameter, actuates clutch piece (1) when sterilizer is subjected to pressure. At 20 pounds pressure in sterilizer the two clutch pieces are held in engagement by more than 400 pounds pressure on diaphragm.

4. Bronze guard protects diaphragm from injury. Steam has access to diaphragm through holes in edge of guard.

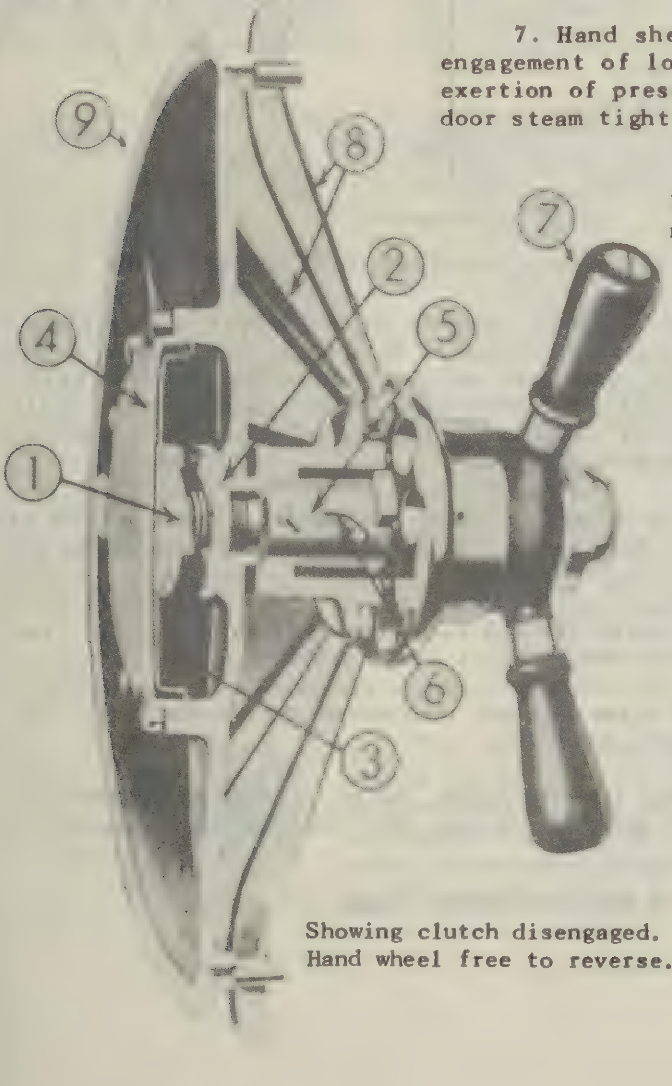
5. Thrust screw in collar of locking lever control plate. There are two screws, one at each side. Ends of thrust screws extend into dam slots (5) and they control the revolution of the control plate, following the path of the slots as the hand wheel is screwed in or out, thus actuating movement of locking arms into or from engagement with the door frame.

6. Cam slot in stationary central stud upon which hand wheel is threaded. There are two slots, one on each side.

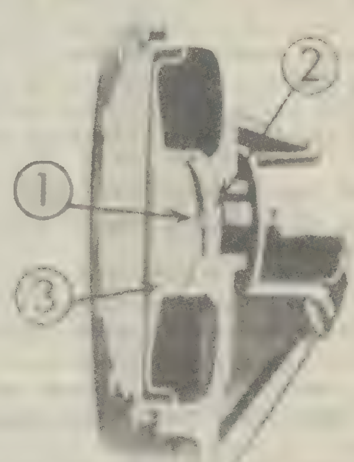
7. Hand sheel with radial handles controls engagement of locking levers with door frame and exertion of pressure upon locking levers to force door steam tight against its flexible gasket.

8. Locking levers of manganese bronze with ball and socket connection to central control plate.

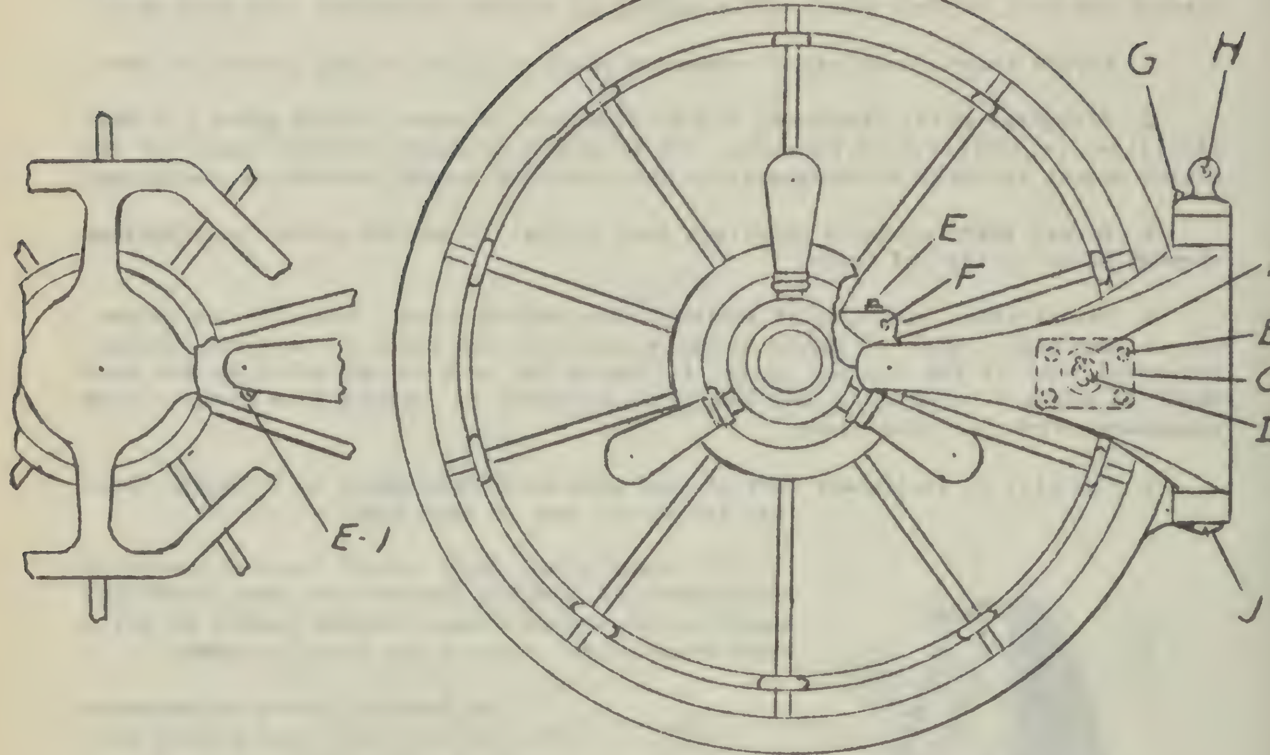
9. One-piece bronze door.



Showing clutch disengaged.
Hand wheel free to reverse.



Showing clutch engaged.
Door cannot be opened
without shearing clutch
teeth.



ADJUSTMENT OF AMERICAN TWO PIECE DRESSING STERILIZER HINGE

The hinge is so designed as to allow the door to adjust itself to any plane, thereby assuring a steam-tight joint with a minimum of tension on the hand wheel and a consequent lessening of wear on the door parts and the ebonite gasket. The self-aligning feature is obtained by a ball and socket suspension at "A". The 4 small screws (B) securing the ball retainer (C) and the one large screw (D) attaching hinge to the ball should be kept tight at all times.

The door should enter the ring centrally, that is, with an equal amount of clearance at any point on the edge. When necessary, the door may be adjusted in the following manner:

To raise the door, loosen set screw (F) and turn screw (E) to the right. For concave type doors turn screw (E-1) to the right.

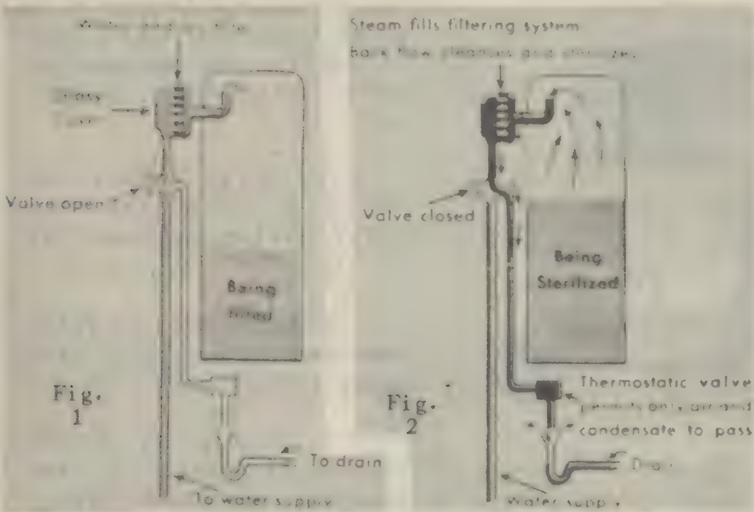
To lower the door, loosen set screw (F) and turn screw (E) to the left. For concave type doors turn screw (E-1) to the left.

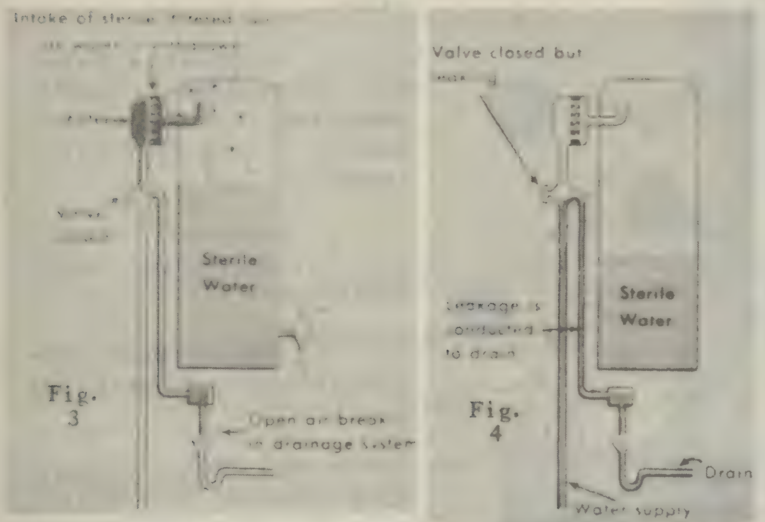
To move the door towards or away from the hinge, first: LOOSEN SET SCREW (G), then by inserting a rod in the hole and turning knob (H), the door may be moved in either direction.

After adjustment is obtained, BE SURE TO TIGHTEN SCREWS (F) AND (G).

To remove hinge pin, remove screw (J).

AMERICAN WATER STERILIZERS, AID AND WATER FILTER - This system provides for filtration of all intaken air through a (permanent) mass of tightly compressed Monel metal wool. Figure 3.





This air filter is contained in the rear of the filter case. It is subjected to the same cleansing and sterilizing back flow of steam as the water filter. It is kept in a moistened condition, for the more effective removal of dust, by sterile condensate.

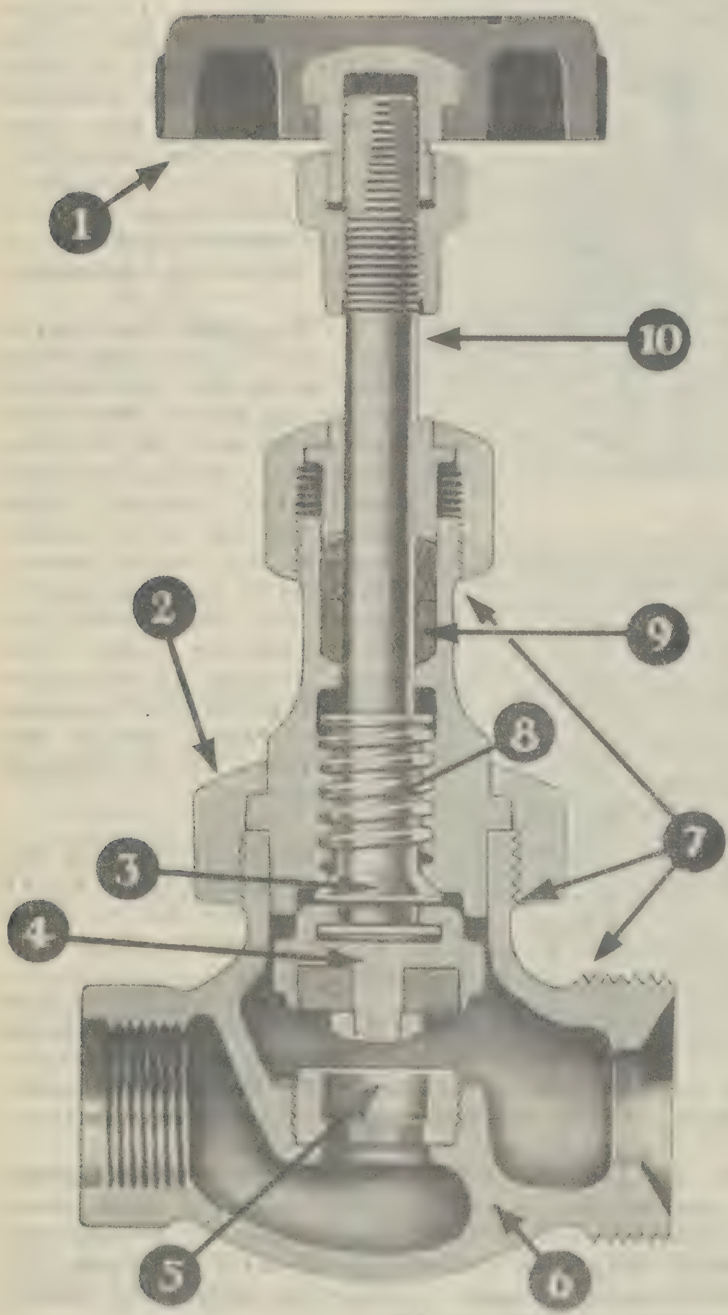
The individual water and air filter has only one valve for control of water and waste. When this valve is open to fill the reservoir, the waste automatically closes. Then when the valve is closed against the flow of water, the waste automatically opens--so that should the valve become leaky, the slow intake of water is conducted to the drainage system, rather than to the reservior, as illustrated by Figure 4.

The glass cover of the filter permits a clear view of the water flow to the operator. Figure 1.

Figure 2 shows how the entire filtering system is backwashed and sterilized by pressure steam--each time water is sterilized. The thermostatic valve permits only water and air to pass, retains the steam under pressure to sterilize.

The cut shows a complete water filter which weighs only a few ounces. A new unit will normally serve three to four months with no servicing whatever. It requires replacement only when a slow flow of water indicates the pores are becoming clogged. A nurse can replace the element in five minutes without any tool.

AMERICAN STERILIZER OPERATING VALVE



1. Cool Bakelite Handle, easily removed but rigidly secured to valve stem. Plain recessed letters with indicative coloring on face of handle show purpose of valve--water, steam, return, etc.

2. Union Bonnet, of phosphor bronze for long life, easily removed for servicing.

3. Upper Seat on Valve Stem permits repacking with valve fully open.

4. Accurately guided slip-on disc holder. Uses standard composition disc--available from any supply store.

5. Removable Valve Seat, of hard Monel, rigidly supported in body, for maximum life and easy servicing.

6. Valve Body, 350 lb. test, steam bronze. Ample fluid space.

7. All threads concealed--smooth exterior surfaces.

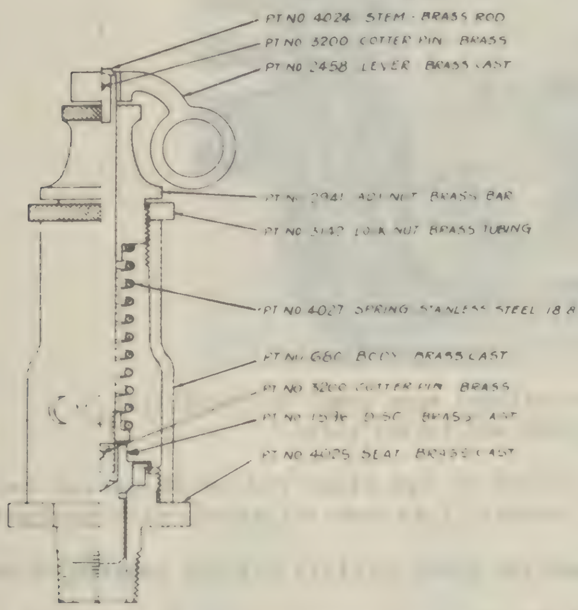
8. Full length standard Acme threads, for maximum strength and wearing properties.

9. Double the usual amount of stem packing--two asbestos reinforced composition rings (pre-formed).

10. Valve Stem of Tobin Bronze for great strength.

SAFETY (POP) VALVES - On pressure sterilizers they are for the purpose of releasing excess pressure within the sterilizer. They are safety devices, as the name indicates, and should, therefore, be frequently inspected and tested.

Safety valves should be tested daily by simply raising the lever arm of the valve when there is pressure in the sterilizer to see if steam will escape freely through the valve. When the arm is released, the valve should close promptly and tightly.



AMERICAN

SAFETY VALVE

The safety valves are set and sealed at the factory to release at about 22 - 25 lbs. pressure in the sterilizer. The setting should not be changed unless checked by means of an accurate steam pressure gauge. If necessary to change the adjustment, proceed as follows:

Remove cotter pin and lever. Loosen lock nut. The pressure at which the safety valve releases is determined by the tension of the spring which is controlled by the adjusting nut. The knurled lock nut is provided to lock the adjusting screw in place after the adjustment has been made.

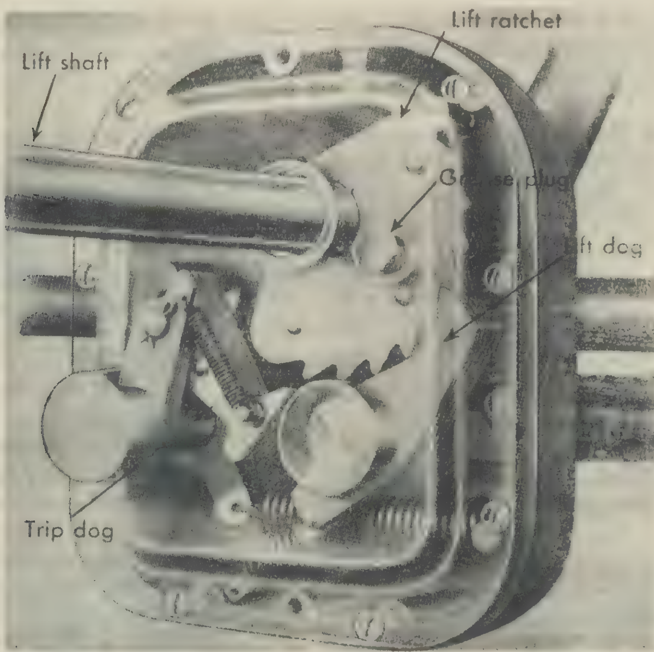
To adjust, loosen lock nut and screw DOWN on the adjusting nut to increase pressure; screw UP on the adjusting nut to decrease pressure. After proper adjustment has been made, tighten lock nut.

If the safety valve leaks steam continuously, the trouble is usually caused by dirt or scale lodging in the valve seat, preventing the valve disc from seating properly. When this occurs, the valve should be removed from the sterilizer, taken apart and carefully cleaned.

DIRECTIONS FOR CLEANING VALVE SEAT - Remove cotter pin and lever, unscrew body from base of valve. Clean valve disc and seat. Reassemble and adjust.

If the valve leaks because of a worn seat or disc, they may sometimes be successfully ground in with a fine valve grinding compound.

AMERICAN STERILIZER MECHANICAL LIFT FOR UTENSIL STERILIZER



Detail of multiple thrust ratchet type cover and tray lift.
Used on 20x20x24 and larger sizes.

1. Forged steel clutch piece secured to hex steel rod which passes freely through hex hole in hand wheel collar causing it to turn inflexibly with hand wheel.

2. Forged steel clutch piece--companion piece to (1) is rigidly secured to door.

3. Allegheny metal diaphragm, 5-1/8" diameter, actuates clutch piece (1) when sterilizer is subjected to pressure. At 20 pounds pressure in sterilizer the two clutch pieces are held in engagement by more than 400 pounds pressure on diaphragm.

4. Bronze guard protects diaphragm from injury. Steam has access to diaphragm through holes in edge of guard.

5. Thrust screw in collar of locking level control plate. There are two screws, one at each side. Ends of thrust screws extend into cam slots (5) and they control the revolution of the control plate, following the path of the slots as the hand wheel is screwed in or out, thus actuating movement of locking arms into or from engagement with the door frame.

6. Cam slot in stationary central stud upon which hand wheel is threaded. There are two slots, one on each side.

7. Hand wheel with radial handles controls engagement of locking levers with door frame and exertion of pressure upon locking levers to force door steam tight against its flexible gasket.

8. Locking levers of manganese bronze with ball and socket connection to central control plate.

9. One-piece bronze door.

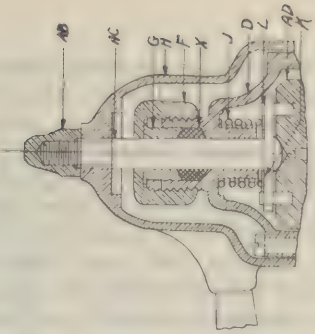


Fig. 7

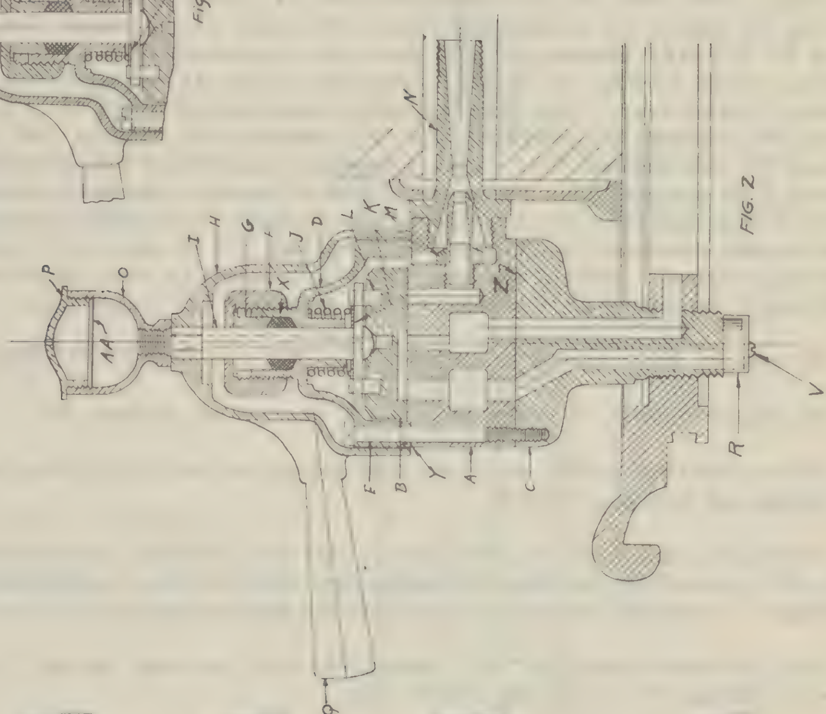


FIG. 2

FIG. 3 FIG. 4 FIG. 5 FIG. 6

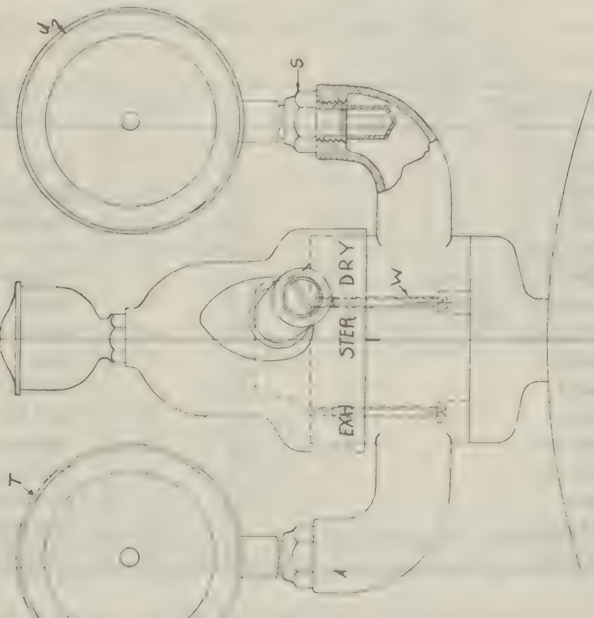


FIG. 1

DESCRIPTION OF TYPE 828 OPERATING VALVE - In referring to this valve always use list of correct names and part numbers as indicated on list at the bottom of this page. The base "C" is identical for all size sterilizers and is attached to End Ring by means of a special length ½" pipe size, taper thread. The threads should be lightly coated with a good pipe cement and screwed in tightly to the position shown in Fig. 2 so that when the valve is assembled the tube "N" points directly to the rear. The Body Assembly consists of Body "A", seat "B", Stem "I", Packing "X", Gland "G", Packing Nut "F", Gasket "Y", Nozzle "M", and Tube "N" held together by two screws "W". This assembly is in turn attached to the Base "C" by means of five screws "E". Unless accidently damaged the valve should perform satisfactorily for the life of the sterilizer without regrinding the seat, or repacking. It may become necessary to tighten Packing Nut "F" in case difficulty is experienced in drawing Vacuum. Should serious trouble develop in the operation of the valve it is advisable to exchange the entire Body Assembly for a new one.

To remove body assembly, remove Cup "O" and Cover "H" then five screws "E".

To separate Body "A" from Bonnet "D" remove two screws "W".

In assembling parts care must be taken to have locating marks (ciphers) on Seat, Stem and Cover, coincide.

Although the valve is designed to operate without lubrication a few drops of Castor Oil placed in the Cup "O" under the cotton filter occasionally will minimize the danger of scoring the valve seat due to foreign matter in the Steam.

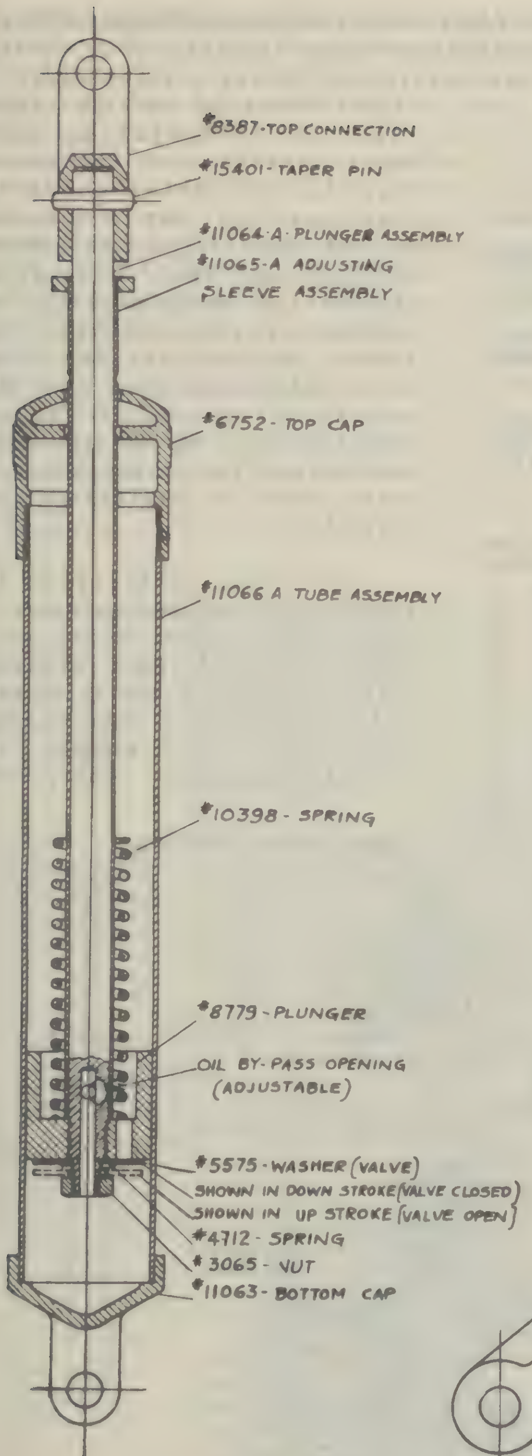
Fig. 3 shows seat in "off" position with passage opened from chamber to atmosphere through the Stem and filter cup.

Fig. 4 shows seat in "DRY" position with port connecting steam from jacket to ejector nozzle "M" which draws air from chamber through port in seat and tube "N".

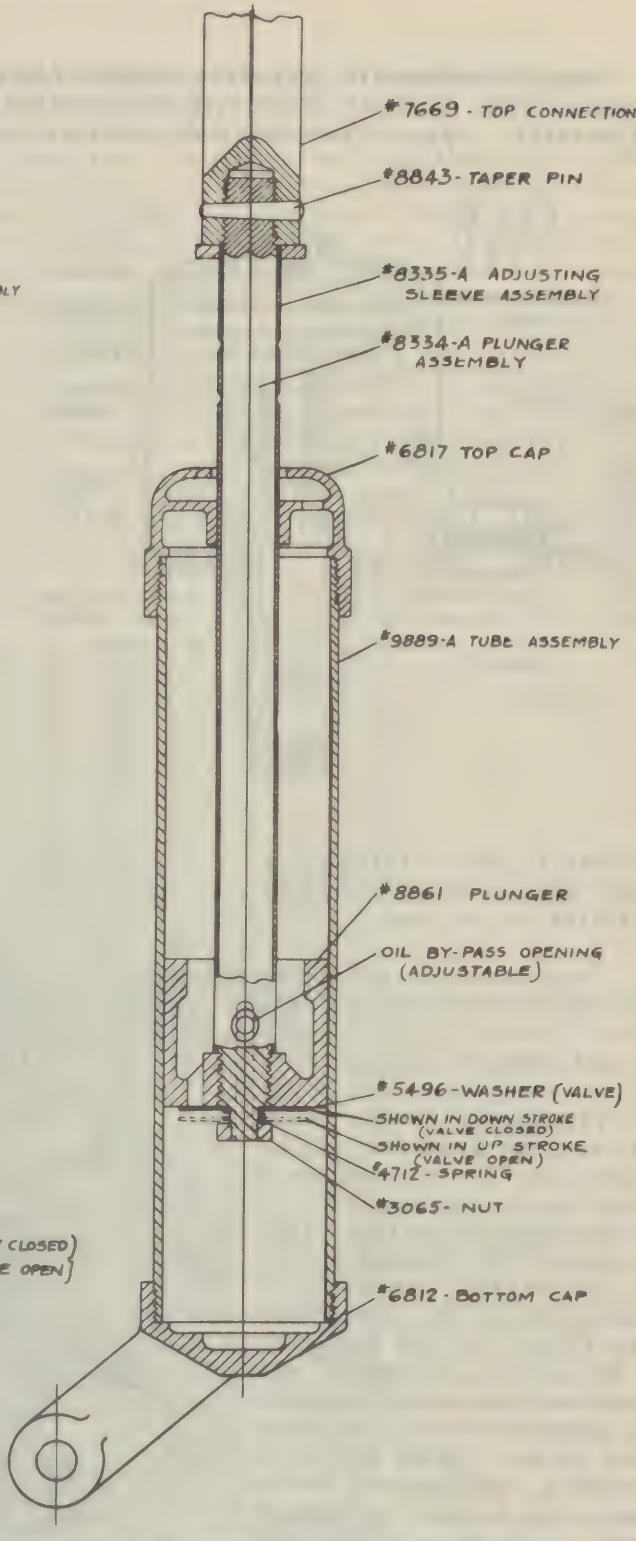
Fig. 5 shows seat in "Ster." position with port connecting steam from jacket to chamber.

Fig. 6 shows seat in "Exh." position with port connecting chamber to exhaust pipe.

SYM	NAME	SYM	NAME
AD	Seat	I	Stem
AC	Stem	J	Spring
AB	Nut	K	Washer
AA	Screen	L	Pin
Z	Gasket - Lower	M	Nozzle
Y	Gasket - Upper	N	Tube
X	Packing	O	Cup
A	Body	P	Cap
B	Seat	Q	Handle
C	Base	R	Deflector
D	Bonnet	S	Syphon
E	Screw	T	Vac. and Pres. Gauge
F	Nut	U	Pressure Gauge
G	Gland	V	Screws
H	Cover	W	Screws



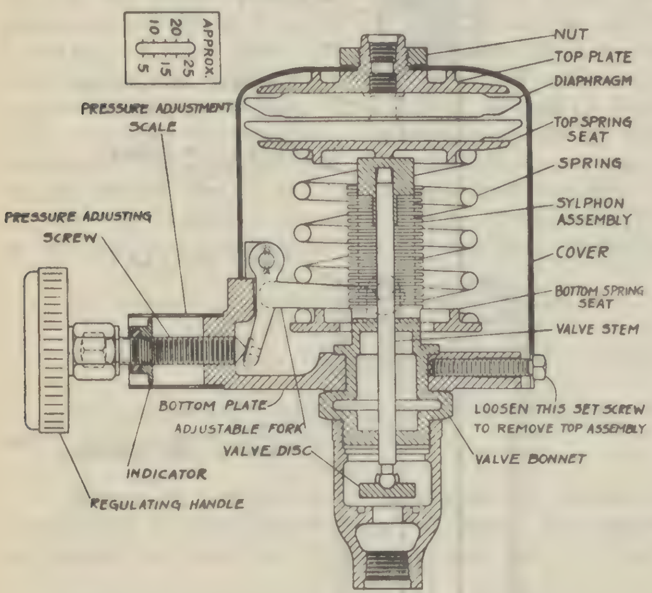
OIL CHECK ASSEMBLY FOR UTENSIL STERILIZERS WITH COVER LIFT ONLY



OIL CHECK ASSEMBLY FOR UTENSIL STERILIZERS WITH COVER - AND TRAY LIFT

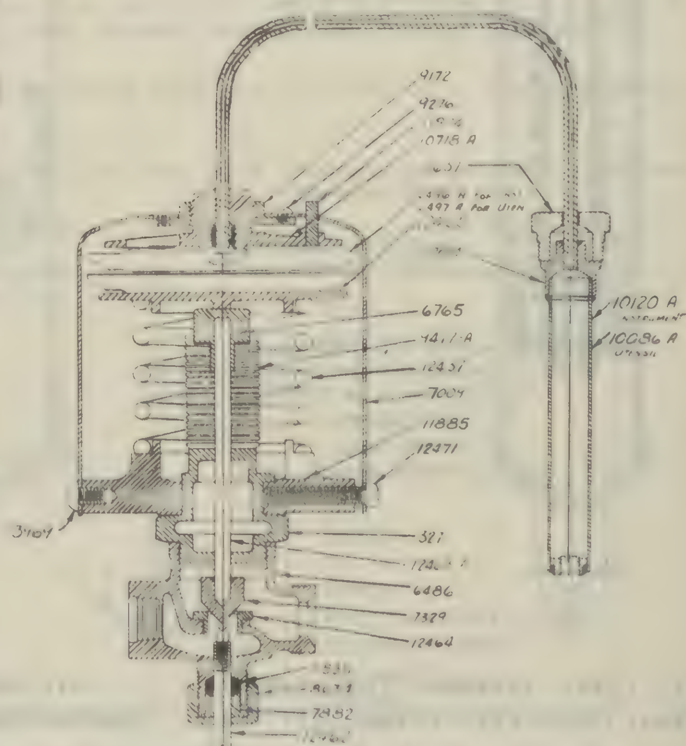
Speed at which lid lowers is controlled by rotating adjusting sleeve assembly, thus increasing or decreasing the size of the oil by-pass opening.

AMERICAN AUTOMATIC SELECTIVE CONTROL VALVE FOR STEAM HEATED DRESSING STERILIZERS - This Automatic Selective Pressure Control Valve is designed to control and maintain a predetermined steam pressure within the dressing sterilizer. A higher pressure for the sterilization of dressings and a lower pressure for the sterilization of rubber goods and other materials may be secured. The maximum differential between the high and low limit is approximately twenty pounds. Any desired pressure within these limits may be attained. Due to a wide variation of steam supply pressures at various installations, the Control Valve must be set for permanent operation after the sterilizers are installed.

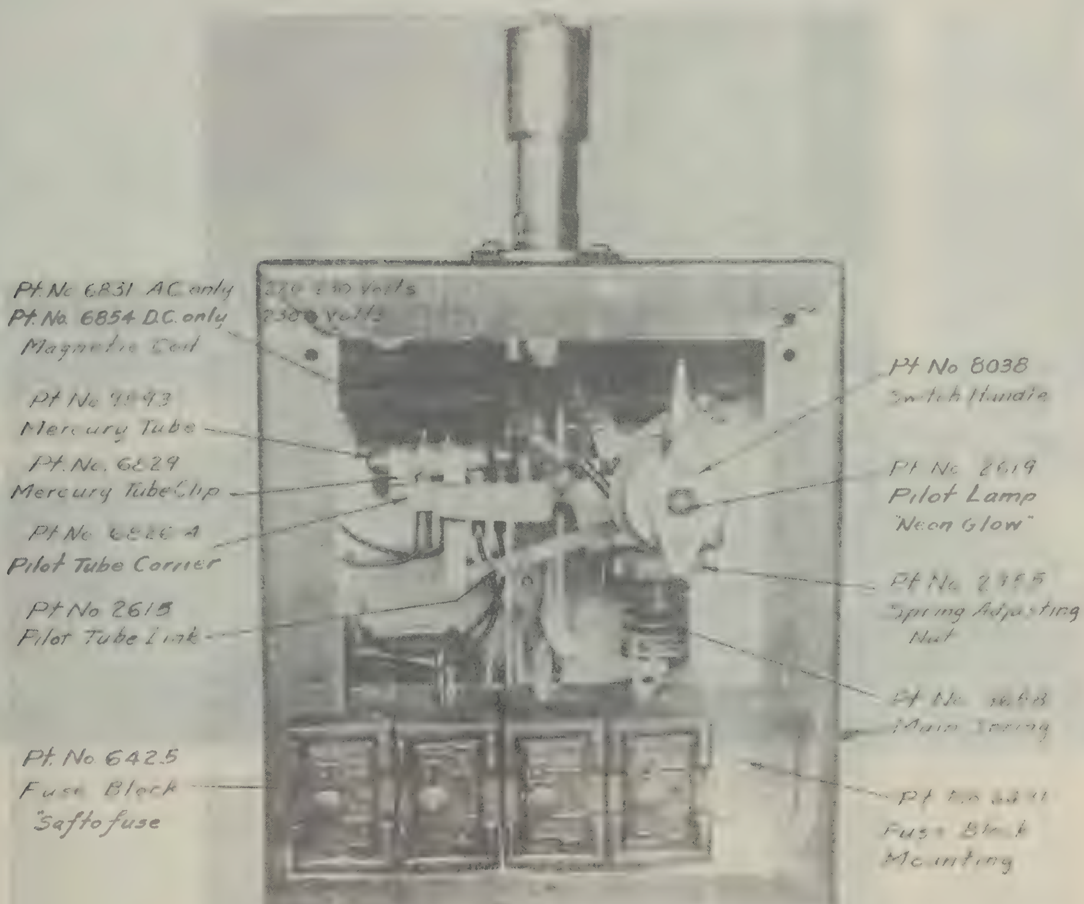


The Control Valve is designed for a maximum pressure of seventy (70) pounds on the steam supply line. A higher pressure will soon destroy the valve seat and bellows. For this reason, should the steam supply line exceed sixty-five (65) pounds pressure at the sterilizers, a steam reducing valve should be installed on the riser.

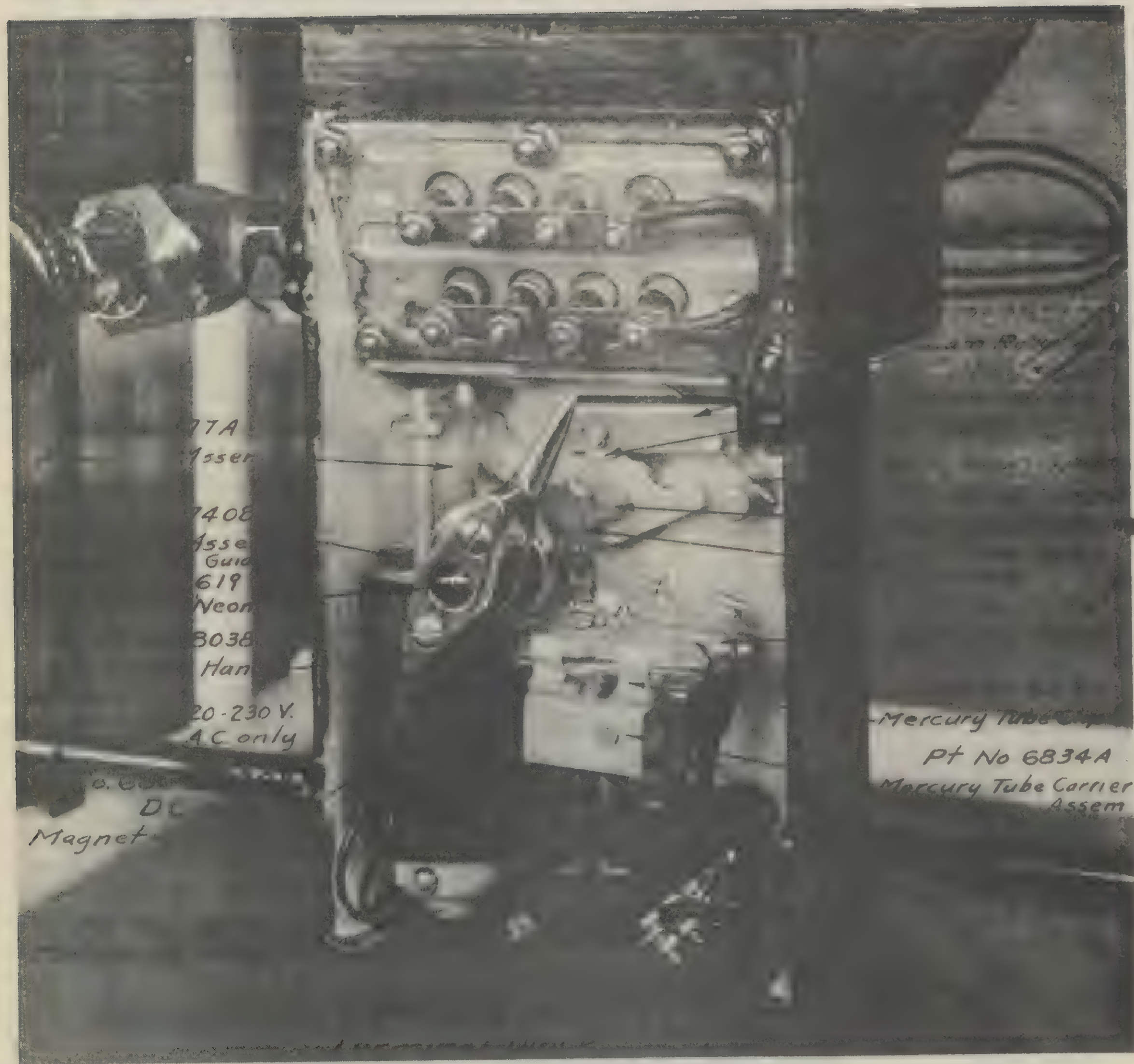
The Steam Control Valve consists of a quick-opening packless valve operated by a large diaphragm which expands or contracts in proportion to the pressure in the sterilizers. The expansion of the diaphragm is governed by a heavy compression spring. As the pressure in the sterilizer approaches the desired level, the diaphragm expands and closes the valve, admitting less steam. As the pressure in the sterilizer lowers, the diaphragm contracts, opening the steam valve and admitting more steam. When properly adjusted, the Control Valve admits the correct amount of steam to maintain a constant steam pressure in the sterilizer.

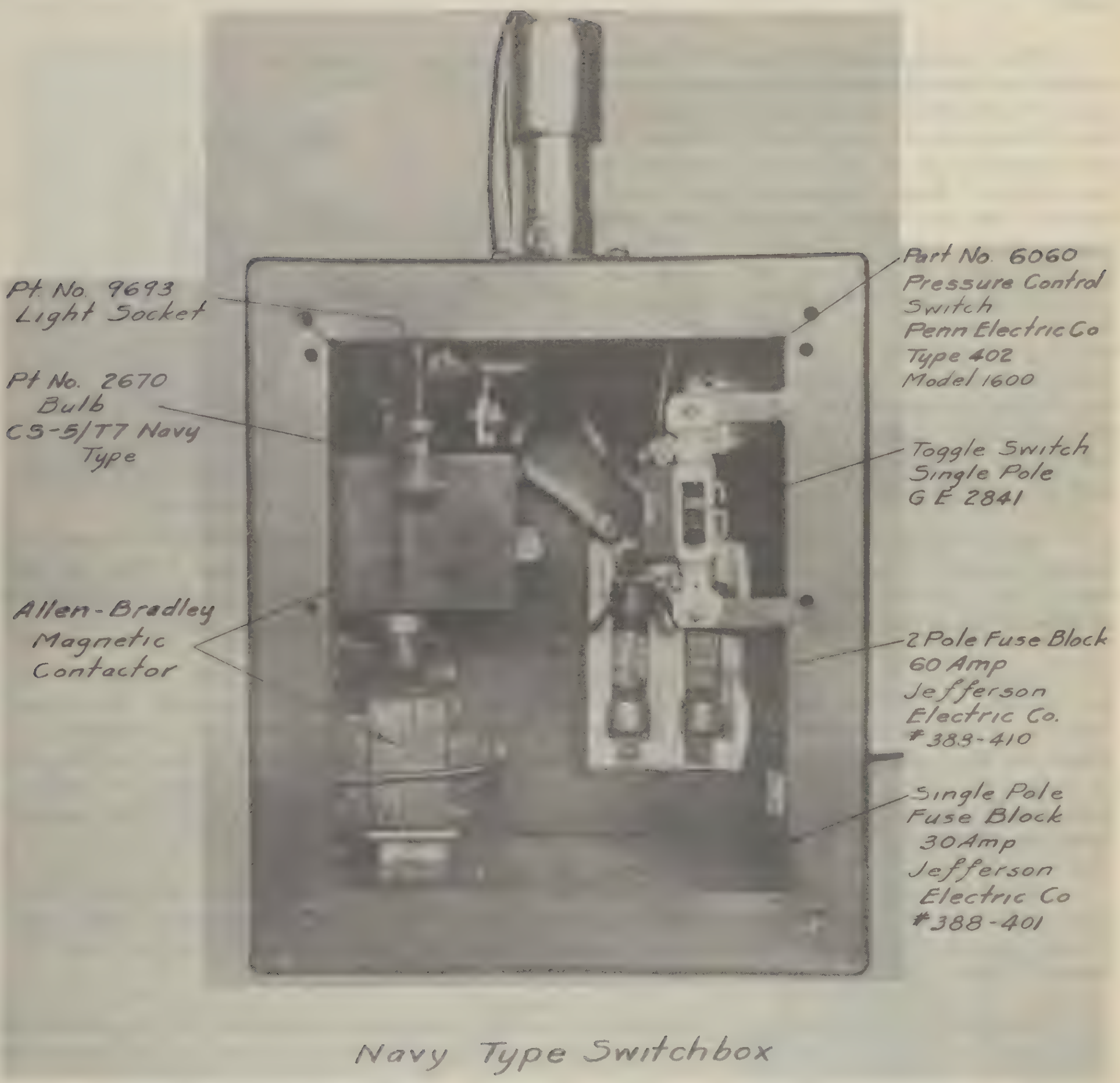


AMERICAN EXCESS VAPOR CONTROL VALVE - The purpose of this valve is to automatically throttle the steam supply on non-pressure sterilizers with the object of preventing excessive boiling and the resulting dissipation of steam. With a few differences this valve works on the same principle as the one described above. The diaphragm, instead of being connected directly to the sterilizer forms part of a thermal unit comprising, in addition, a bellows and capilliary tube. The entire thermal unit is filled with a highly volatile fluid. The valve is placed in a fitting attached to the vent opening of the sterilizer. When the water in the sterilizer starts to boil, the steam circulates around the valve, heating the volatile fluid and causing it to expand. The expansion is transmitted to the bellows which in turn shuts off the valve. However, in order to keep the water in the sterilizer at boiling temperature, a certain amount of steam must be permitted to pass through the valve and through the steam coil. It will be noted that set screw No. 12462 can be screwed up against the valve disc No. 7329 and can, in fact, hold the disc off the seat. Thus, by adjusting the screw a greater or lesser opening can be made for the passage of steam. To increase the amount of steam flowing through one turns the screw clockwise, to decrease it, counter-clockwise. It will be necessary from time to time to tighten the packing nut through which this adjusting screw passes.



Mercury Type Switchbox


20-230 V.
A C only
Magnet
Pt No 6834A
Mercury Tube Carrier
Assem



Navy Type Switchbox

THE COMBINED WATER AND AIR FILTER - The filtering unit filters raw water as it flows to the reservoir and also filters all air drawn into the reservoir. While the reservoir is undergoing sterilization, the entire filtering system is automatically sterilized. The water filtering element consists of three removable filtering discs held in place by a perforated metal cover in front, with hollow perforated metal separators between discs, against a perforated back wall which covers the air filtering unit consisting of tightly compressed non-corrosive metal wool.

The valve controlling raw water supply to the filter is a double action valve which when opened admits water to the filter and automatically closes the rear connection on the valve leading to the drain. When the valve is closed, water flow is shut off and the rear connection to the drain is opened. Then, should the valve leak slightly, leakage is conducted directly to the drain instead of the water reservoir. During sterilization steam from the reservoir passes through the filter to the filter (thermostatic) trap is heated when the trap closes, holding the entire filtering system under pure steam pressure as long as sterilization continues.

An air intake tube connects the air filtering compartment direct to the air vented waste. A ball check in the filter case prevents flow from the filter to the waste but admits air freely under the slightest back pressure as when water is withdrawn from the reservoir or when the sterilized reservoir cools down.

Sluggish flow of water from the reservoir may mean that the ball check in the air intake is adhering to the seat. To clean the ball check, remove the water filtering pads and take out the six screws which hold the air filtering element in place in the rear of the filter case. There are two extra tapped holes in the rim of this air filtering element for use in breaking the element loose from its gasket. Just insert two of the six screws in these holes and screw them in until the gasket lets go. This will expose the ball check for cleaning.

If water does not discharge from the filter case during sterilization, that will indicate clogging or fatiguing of the filter trap. Remove the top of the trap, clean the outlet and if necessary replace the trap element, available from the nearest source of supply.

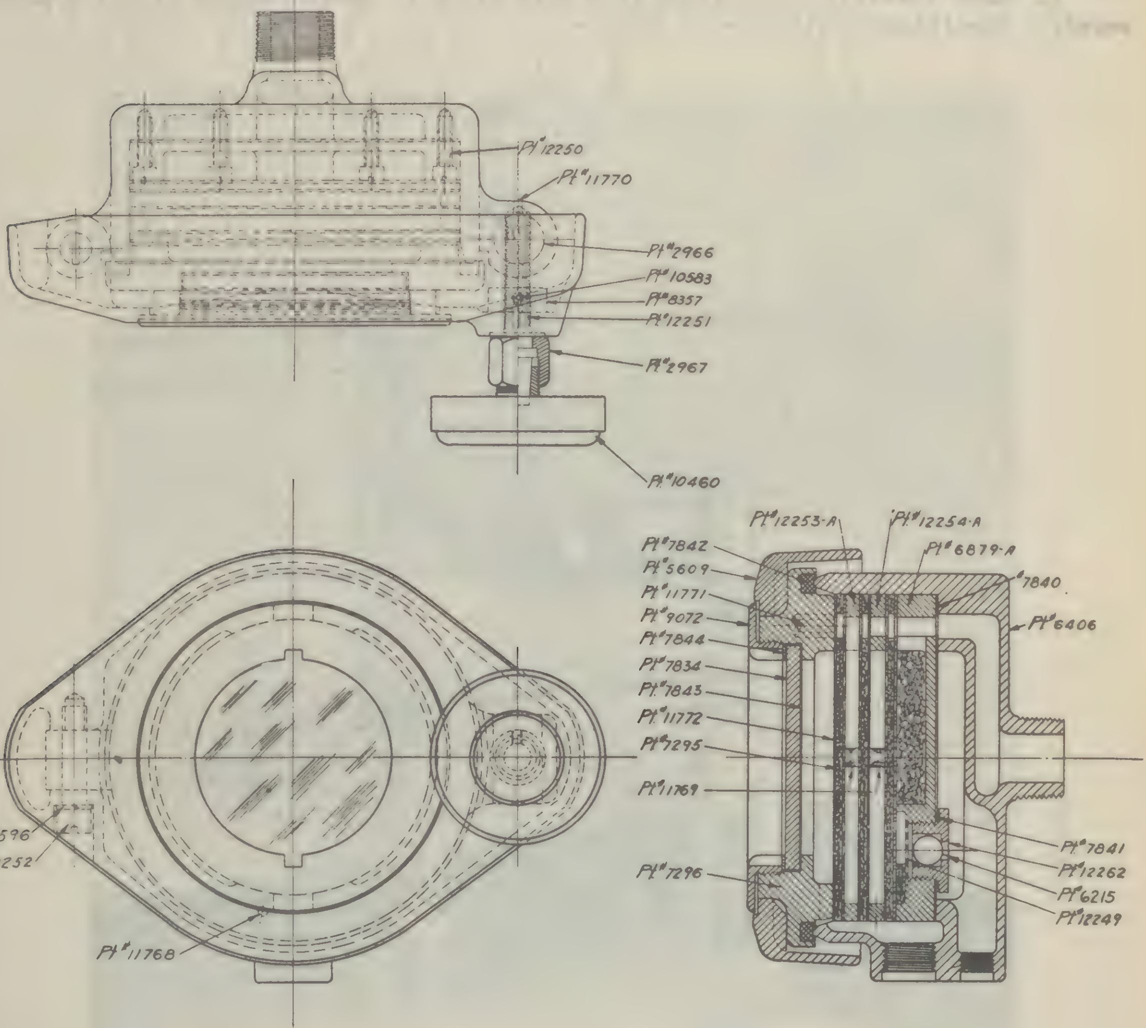
TO OPEN FILTER CASE - Turn cover handle counter-clockwise until door is free but do not attempt to open case except when sterilizer is cold or free from pressure.

TO REMOVE WATER FILTER UNIT - With filter case cover open, grasp two knurled guide pins at top. Slight effort will remove complete water filter assembly. Rear water filter disc may adhere to back wall. Wipe back wall clean before putting in new element.

TO ASSEMBLE NEW WATER FILTER UNIT - The rear plate has guide pins attached.

Front side of this plate is the one on which guide pins are knurled. Place a fresh filter disc on each side of this plate, then place front spacer (one having no guide pins) on top of renewed filter disc, on front side. Now place the third filter disc on top of this spacer and finally, place perforated cover plate on top of third filter disc. This completes assembly of unit. To replace unit in filter case, hold assembled unit by knurled ends of guide pins and insert unit in case so that guide pins enter locating holes in rear of case top. Close cover and tighten firmly with cover handle.

New water filter pads in cartons of 48 can be secured from nearest source of supply. Filter case gaskets, cut to exact size, are also available from stock.



AMERICAN WATER AND AIR FILTER

SPECIAL PARTS SECTION

DIRECTIONS FOR ASSEMBLING STERILIZER

1. Remove sterilizer from crate. This sterilizer is shipped assembled with the exception of Water Filling Valve 5653-A, and Waste Funnel which will be found inside sterilizer box.

2. Place Valve 5653-A, in top of Water Fill Fitting 8418 as shown in Fig. 10.

3. Then connect with hot water supply.

4. Waste funnel must be placed in Waste Trap.

5. Sterilizer is then set so tubing tail piece at rear of sterilizer will empty into this funnel. Leave a 2" Air Gap between top of funnel and bottom end of tail piece.

6. Make electric connections from fuse block in Switch Box to electric power supply. Sterilizer is then ready for use.

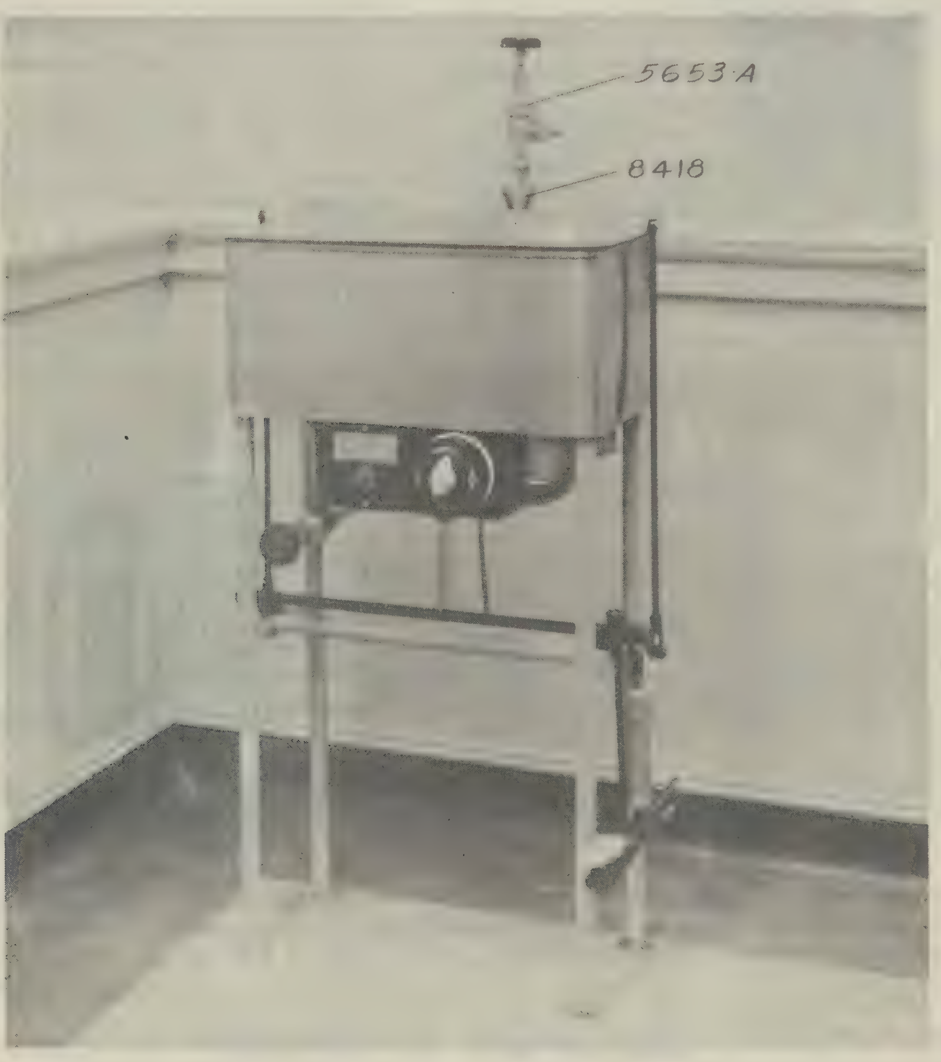
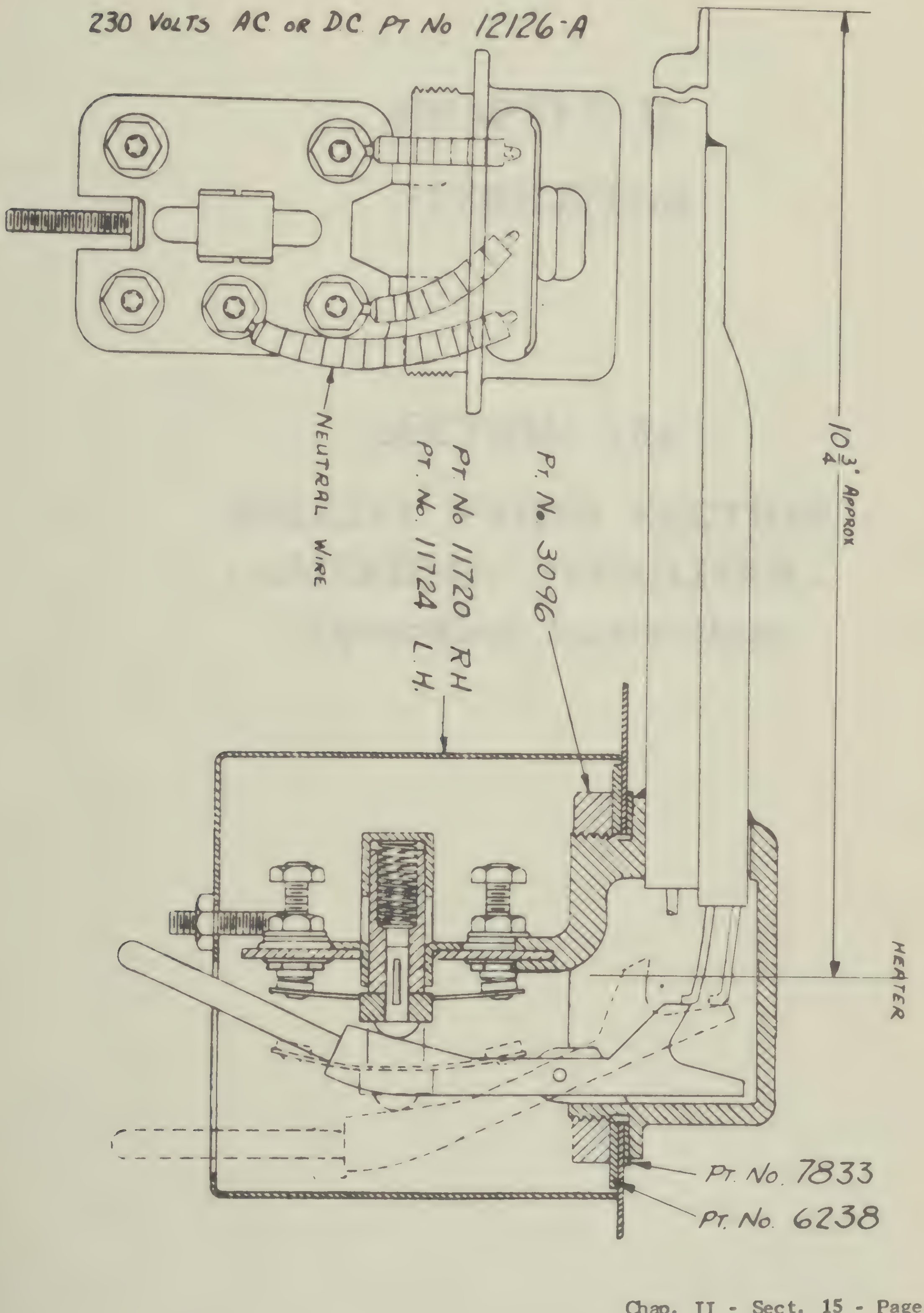


FIGURE 10

AMERICAN ELECTRIC CUTOUT HEATER ASSEMBLY - TYPE "D"

115 VOLTS AC OR DC. PT No. 12125-A

230 VOLTS AC OR DC PT No 12126-A



CHAPTER II

STERILIZERS

SECTION 15a

SPECIAL PARTS SECTION
- AMERICAN STERILIZER -
Operating Instructions

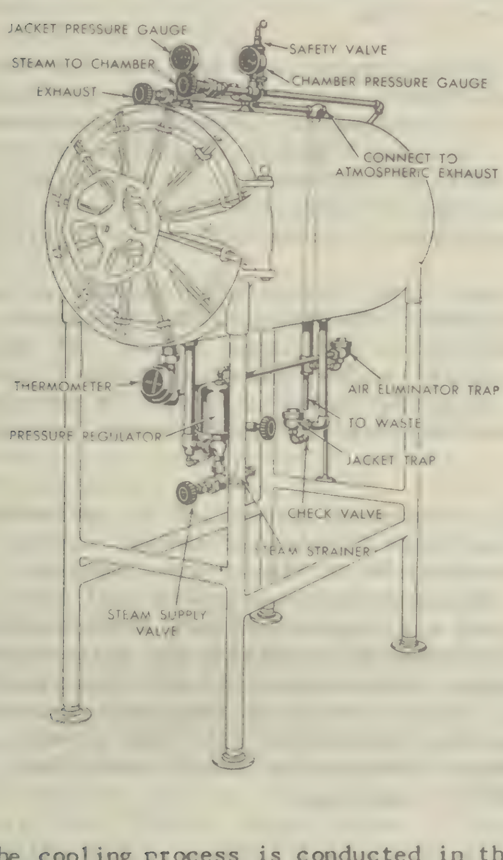
SPECIAL PARTS SECTION

AMERICAN AUTOCLAVE
ALL-STEEL CONSTRUCTION
(STEAM HEAT)

DIRECTIONS FOR USE

TO HEAT JACKET - Close "Steam to Chamber" and "Exhaust" valves and open "Steam Supply" valve. Do not attempt to sterilize until "Jacket Gauge" shows 15-17 pounds pressure.

TO STERILIZE ALL MATERIALS - With load in sterilizer, door locked and "Jacket Gauge" showing 15-17 pounds pressure, open "Steam to Chamber" valve full. Operator should remain at close attention until "Thermometer" shows 240° F. Note this time as beginning of exposure period. Within following three to five minutes, temperature should gradually advance to a maximum of 250°-254° F. Careful attention to temperature and timing is essential. Operator should not leave room during exposure period.



EXHAUSTING STEAM FROM CHAMBER, FOR ALL MATERIALS EXCEPT SOLUTIONS - At close of exposure period close "Steam to Chamber" valve and open "Exhaust" valve full. Only when "Chamber Gauge" shows "0" pressure, unlock the door. To insure excellent drying effect, loosen the door very slightly from its gasket so that it is opened not more than one-half inch. Vapor will escape from the top of the door opening with decreasing intensity for five minutes or more, depending upon the size and density of the load. Five to ten minutes is usually adequate for satisfactory drying, after which the door may be opened wide and the load removed. Do not close "Steam Supply" valve until drying is complete.

TO COOL SOLUTIONS FOLLOWING STERILIZATION - At close of period of exposure, close "Steam to Chamber" valve and very slightly open (crack) the "Exhaust" valve, watching the "Chamber Gauge" and adjusting the opening of the valve to insure slow reduction of chamber pressure. The period of exhaust from the sterilizing range to "0" pressure should be not less than seven minutes. Do not unlock the door until chamber pressure is completely exhausted. If the cooling process is conducted in this manner, there will be no ebullition of the fluids when the door is opened, but if pressure is exhausted more rapidly solution will be seen boiling more or less voilently, stoppers will be loosened or blown off and there will be considerable loss of fluid from the flasks. Remove solutions from sterilizer at once to permit more rapid (and desirable) cooling to room temperature.

SHUT OFF STEAM SUPPLY VALVE - Unless sterilizer is to be used again at once, close this valve and permit sterilizer to cool.

PRESSURE REGULATOR - This sterilizer has automatic pressure regulation. We advocate operation for all sterilization at 15-17 pounds (actual) pressure and the sterilizer is adjusted at the facotry for this range. Should readjustment become necessary, turn on heat until both jacket and chamber pressures become stable at the maximum range, then turn the adjustment handle just under the regulator clockwise to increase, counter-clockwise to reduce pressure until the desired range has been attained. The significant factor is to so regulate the pressure that the thermometer indicates maximum temperature of 250°- 254°F. when the pressure has become stable at the regulated range. Pressure gauges of all makes are apt to read high, indicated by failure of the pointer to return to "0" when the sterilizer is cold. Commercial gauges are accurate only within one or two pounds and sometimes indicate several pounds low, due to fatigue in service. Thermometers as applied are much more accurate and stable, for which reason we advocate regulation with specific regard for temperature developed. Not Infrequently the pressure gauge will (falsely) indicate 20 pounds or higher before the temperature as indicated by the therometer will advance to 250°-254° F. If such faulty reading of the pressure gauges is encountered, they should be readjusted to conform with the thermometer indication.

THE STEAM SUPPLY SYSTEM - Particularly when sterilizer is first put into service, check steam strainer at frequent intervals to see that there is no interruption to steam flow. If there is complaint of slow heating, check steam strainer first, then check steam supply maintenance. Any considerable variation in steam supply pressure will be reflected in sterilization regulation. If sterilizer is noisy in heating up, that indicates carrying over of water with steam. The only remedy is to drain steam supply of condensate before steam reaches sterilizer.

THE RETURN SYSTEM - Sterilizer is equipped with thermostatic steam trap and check valve in return from jacket. This line must discharge into a non-pressure return system. Trap will not function if connected to a pressure return. If there is evidence that trap is not functioning properly, secure new element for trap or an entirely new trap from source of supply. Order by number on trap. Do not confuse this trap with eliminator trap on chamber discharge. They have same external appearance but have different elements.

INSPECTION OF CHAMBER DISCHARGE SYSTEM - Frequent inspection is advisable, to keep this line clean and operating correctly. If plug screen on inside of chamber is kept clear by daily cleaning, there will be little if any clogging. If pores of screen are clogged or if screen is broken or removed, there will be difficulty. If dirt gets into line, it will clog air eliminator trap which must be taken apart for cleaning. In sterilizing, thermometer will indicate any interruption to free drainage. If line is completely clogged, temperature will not rise at all. First check plug screen. If this is clean, check eliminator trap and clear all piping of sediment. If there is partial clogging, temperature will rise slowly and it is best to clean out the entire line. Under no condition should sterilizer be used unless temperature does rise to 250°-254° F. maximum.

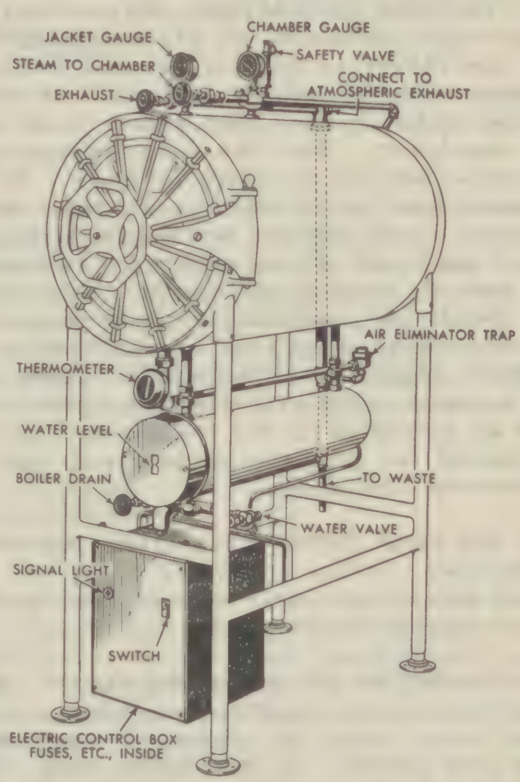
On rare occasions, element in eliminator trap will fatigue, shut off too soon. Indication will be a definite lag in temperature rise. Maximum may drop to 230°-240° F. The only remedy is to secure a new trap element or an entirely new trap. In ordering either, specify by number on trap cover.

THE DOOR - At intervals of three months or oftener if there is any indication of binding, put a few drops of light machine oil on threads of stud on which door centers, and in oil hole of door collar -- back of handwheel.

THE DOOR GASKET - When door fails to close steam tight under normal closing pressure, without straining handwheel, renew gasket which canbe secured from nearest source of supply. In removing old gasket, scrape groove in door frame clean. Gasket is cut to a tight fit in groove and must be forced in, a short section at a time, without stretching. Should gasket appear to be too long, do not cut it, but start over again, compressing short sections as inserted in groove, to take up full length. Coat face of gasket with powdered graphite mixed with water, or lacking graphite, use talcum powder with water, to prevent gasket from sticking to door under heat. Close door tight to seat gasket firmly.

AMERICAN AUTOCLAVE
ALL-STEEL CONSTRUCTION
(ELECTRIC HEAT)

TO HEAT JACKET - Open "Steam to Chamber" and "Exhaust" valves and fill boiler with water by opening "Water" valve until "Water Level" indicator shows "Full". Do not fill beyond "Full" line. If too much water is admitted, open "Drain" valve until indicator shows "Full". Now, close "Steam to Chamber" and "Exhaust" valves and turn on "Switch" but do not attempt to sterilize until "Jacket Gauge" shows 15-17 pounds pressure.



TO STERILIZE ALL MATERIALS - With load in sterilizer, door locked and "Jacket Gauge" showing 15-17 pounds pressure, open "Steam to Chamber" valve full. Operator should remain at close attention until "Thermometer" shows 240° F. Note this time as beginning of exposure period. Within following three to five minutes, temperature should gradually advance to a maximum of 250°-254° F. Careful attention to temperature and timing is essential. Operator should not leave room during exposure period.

EXHAUSTING STEAM FROM CHAMBER, FOR ALL MATERIALS EXCEPT SOLUTIONS - At close of exposure period, close "Steam to Chamber" valve and open "Exhaust" valve full. Only when "Chamber Gauge" shows "0" pressure, unlock the door. To insure excellent drying effect, loosen the door very slightly from its gasket so that it is opened not more than one-half inch. Vapor will excape from the top of the door opening with decreasing intensity for five minutes or more, depending upon the size and density of the load. Five to ten minutes is usually adequate for satisfactory drying, after which the door may be opened wide and the load removed. Do not turn off switch until drying of load is complete.

TO COOL SOLUTIONS FOLLOWING STERILIZATION - At close of period of exposure, close "Steam to Chamber" valve and very slightly open (crack) the "Exhaust" valve,

watching the "Chamber Gauge" and adjusting the opening of the valve to insure slow reduction of chamber pressure. The period of exhaust from the sterilizing range to "0" pressure should be not less than seven minutes. Do not unlock the door until chamber pressure is completely exhausted. If the cooling process is conducted in this manner, there will be no ebullition of the fluids when the door is opened, but if pressure is exhausted more rapidly solutions will be seen boiling more or less violently, stoppers will be loosened or blown off and there will be a considerable loss of fluid from the flasks. Remove solutions from sterilizer at once to permit more rapid (and desirable) cooling to room temperature.

TURN OFF SWITCH - Unless sterilizer is to be used again at once turn "Switch" off and permit sterilizer to cool. (Always check water supply before starting up sterilizer for a second or third run after filling boiler.)

PRESSURE REGULATION - This sterilizer has automatic pressure regulation. We advocate operation for all sterilization at 15-17 pounds (actual) pressure and the sterilizer is adjusted at the factory for this range. Should readjustment become necessary, turn on heat until both jacket and chamber pressures become stable at the maximum range, then remove front cover of switch box which gives access to the regulator. Turn the range adjusting screw clockwise to increase pressure; counter-clockwise to reduce pressure. The significant factor is to so regulate the pressure that the thermometer indicates maximum temperature of 250°-254° F. when the pressure in the chamber has become stable at the regulated range. Pressure gauges of all makes are apt to read high, indicated by failure of the pointer to return to "0" when the sterilizer is cold. Commercial gauges are accurate only within one or two pounds and sometimes indicate several pounds low, due to fatigue in service. Thermometers as applied are much more accurate and stable for which reason we advocate regulation with specific regard for temperature developed. Not infrequently the pressure gauge will (falsely) indicate 20 pounds or higher before the temperature as indicated by the thermometer will advance to 250°-254° F. If such faulty reading of the gauges is encountered, they should be readjusted to conform with the thermometer indication.

LOW WATER CUTOUT - Sterilizer has float type low water cutout which functions as follows: Float in boiler rises and falls with water level. When boiler is nearly empty, the heater circuit opens and only when water has been replenished will heater circuit remain closed.

INSPECTION OF HEATER AND FLOAT - At intervals of six months (three months if water is very hard) inspect and clean heater and float. Open boiler "drain valve" until water is exhausted, then: *BEFORE INSPECTING ELECTRIC CIRCUITS, OPEN MAIN LINE SWITCH. DO NOT DEPEND UPON* "PULLED FUSES".

First remove heater cover and disconnect all terminals of wiring leading to switch box. Remove screws which hold float head against gasket and remove float which must be handled with care to avoid any distortion. Remove scale deposits. If necessary, soak scale coated parts only in 10%-20% muriatic acid to soften scale. Avoid acid on terminals. Then remove screws which hold heater head and take out heater. Clean free scale and mud from boiler. Make sure drain outlet is clear. If heater is coated with lime, soak elements in 10%-20% muriatic acid until scale softens sufficiently for cleaning. Confine acid to heater elements with protection of terminals. In replacing float and heater heads, see that gasket is in perfect condition. Terminal studs and connectors have identical numbers to simplify re-assembly and wiring diagram will be found on inside cover of switch box. After cleaning, test sterilizer under pressure. Do not put sterilizer into service unless float and heater heads are perfectly tight.

INSPECTION OF CHAMBER DISCHARGE SYSTEM - Frequent inspection is advisable, to keep this line clean and operating correctly. If plug screen on inside of chamber is kept clear by daily cleaning, there will be little if any clogging. If pores of screen are clogged or if screen is broken or removed, there will be difficulty. If dirt gets into line, it will clog air eliminator trap which must be taken apart for cleaning. In sterilizing, thermometer will indicate any interruption to free drainage. If line is completely clogged, temperature will not rise at all. First check plug screen. If this is clean, check eliminator trap and clear all piping of sediment. If there is partial clogging, temperature will rise slowly and it is best to clean out the entire line. Under no condition should sterilizer be used unless temperature does rise to 250°-254° F. maximum.

On rare occasions, element in eliminator trap will fatigue, shut off too soon. Indication will be a definite lag in temperature rise. Maximum may drop to 230°-240° F. The only remedy is to secure a new trap element or an entirely new trap. In ordering either, specify by number on trap cover.

THE DOOR - At intervals of three months or oftener if there is any indication of binding, put a few drops of light machine oil on threads of stud on which door centers, and in oil hole of door collar--back of handwheel.

THE DOOR GASKET - When door fails to close steam tight under normal closing pressure without straining handwheel, renew gasket which can be secured from our nearest source of supply. In removing old gasket, scrape groove in door frame clean. Gasket is cut to a tight fit in groove and must be forced in, a short section at a time, without stretching. Should gasket appear to be too long, do not cut it, but start over again, compressing short sections as inserted in groove, to take up full length. Coat face of gasket with powdered graphite mixed with water, or lacking graphite, use talcum powder with water, to prevent gasket from sticking to door under heat. Close door tight to seat gasket firmly.

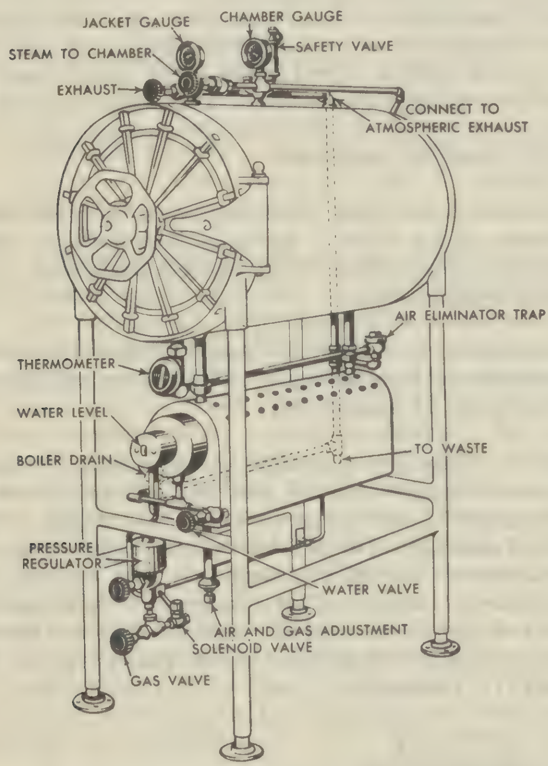
AMERICAN AUTOCLAVE
ALL-STEEL CONSTRUCTION
(GAS HEAT)

TO HEAT JACKET - Open "Steam to Chamber" and "Exhaust" valves and fill boiler with water by opening "Water" valve until "Water Lever" indicator shows "Full". Do not fill beyond "Full" line. If too much water is admitted, open "Drain" valve until indicator shows "Full". Now, close "Steam to Chamber" and "Exhaust" valves and open "Gas" valve full. Pilot light will ignite gas. Do not attempt to sterilize until "Jacket Gauge" shows 15-17 pounds pressure.

TO STERILIZE ALL MATERIALS - With load in sterilizer, door locked and "Jacket Gauge" showing 15-17 pounds pressure, open "Steam to Chamber" valve full. Operator should remain at close attention until "Thermometer" shows 240° F. Note this time as beginning of exposure period. Within following three to five minutes, temperature should gradually advance to a maximum of 250°-254° F. Careful attention to temperature and timing is essential. Operator should not leave room during exposure period.

EXHAUSTING STEAM FROM CHAMBER, FOR ALL MATERIALS EXCEPT SOLUTIONS - At close of exposure period, close "Steam to Chamber" valve and open "Exhaust" valve full. Only when "Chamber Gauge" shows "0" pressure, unlock the door. To insure excellent drying effect, loosen the door very slightly from its gasket so that it is opened not more than one-half inch. Vapor will escape from the top of the door opening with decreasing intensity for five minutes or more, depending upon the size and

density of the load. Five to ten minutes is usually adequate for satisfactory drying, after which the door may be opened wide and the load removed. Do not turn off gas until drying of load is complete.



TO COOL SOLUTIONS FOLLOWING STERILIZATION - At close of period of exposure, close "Steam to Chamber" valve and very slightly open (crack) the "Exhaust" valve, watching the "Chamber Gauge" and adjusting the opening of the valve to insure slow reduction of chamber pressure. The period of exhaust from the sterilizing range to "0" pressure should be not less than seven minutes. Do not unlock the door until chamber pressure is completely exhausted. If the cooling process is conducted in this manner, there will be no ebullition of the fluids when the door is opened, but if pressure is exhausted more rapidly solutions will be seen boiling more or less violently, stoppers will be loosened or blown off and there will be a considerable loss of fluid from the flasks. Remove solutions from sterilizer at once to permit more rapid (and desirable) cooling to room temperature.

TURN OFF GAS - Unless sterilizer is to be used again at once, turn "Gas" valve off. (Always check water supply before starting up sterilizer for a second or third run after filling boiler.)

PRESSURE REGULATION - This sterilizer has automatic pressure regulation. we advocate operation for all sterilization at 15-17 pounds (actual) pressure and the sterilizer is adjusted at the factory for this range. Should readjustment become necessary, turn on heat until both jacket and chamber pressures become stable at the maximum range, then turn the adjustment handle just under the regulagor clockwise to increase; counter-clockwise to reduce pressure until the desired range has been attained. The significant factor is to so regulate the pressure that the thermometer indicates maximum temperature of 250°-254° F. when the pressure has become stable at the regulated range. Pressure gauges of all makes are apt to read high, indicated by failure of the pointer to return to "0" when the sterilizer is cold. Commercial gauges are accurate only within one or two pounds and sometimes indicate several pounds low, due to fatigue in service. Thermometers as applied are much more accurate and stable for which reason we advocate regulation with specific regard for temperature developed. Not infrequently the pressure gauge will (falsely) indicate 20 pounds or higher before the temperature as indicated by the thermometer will advance to 250°-254° F. If such faulty reading of the pressure gauges is encountered, they should be readjusted to conform with the thermometer indication.

PILOT LIGHT - Needle valve for adjustment of pilot light is provided. Adjust to a suitable low flame and leave on continuously.

LOW WATER CUTOUT - Sterilizer has float type low water cutout which functions as follows: Float in boiler rises and falls with water level. When boiler is nearly empty, electric circuit opens on float head, causing electric valve to shut off and it will remain closed until water in boiler is replenished. Unless "Gas Valve" has been manually closed, refilling with water will permit pilot light to ignite gas so that performance can continue.

INSPECTION OF BOILER AND FLOAT - At intervals of six months (three months if water is very hard) inspect and clean boiler and float. Open boiler drain valve until water is exhausted, then: Pull electric plug from wall socket, remove float head cover and disconnect terminals. Then detach two screws which hold boiler head finishing cover in place, exposing boiler heat. Remove all cap screws from rim, then insert two of these screws in extra holes and force them in gently to release head from gasket. Remove head with float very carefully to avoid any distortion. Clean scale thoroughly from boiler and float and flush out boiler. If necessary, use 10%-20% muriatic acid to soften scale, but do not permit acid to touch outside of head. In replacing boiler head, see that gasket is in perfect condition. Test sterilizer under pressure and do not put into service unless boiler head is perfectly tight.

INSPECTION OF CHAMBER DISCHARGE SYSTEM - Frequent inspection is advisable, to keep this line clean and operating correctly. If plug screen on inside of chamber is kept clear by daily cleaning, there will be little if any clogging. If pores of screen are clogged or if screen is broken or removed, there will be difficulty. If dirt gets into line, it will clog air eliminator trap which must be taken apart for cleaning. In sterilizing, thermometer will indicate any interruption to free drainage. If line is completely clogged, temperature will not rise at all. First check plug screen. If this is clean, check eliminator trap and clear all piping of sediment. If there is partial clogging, temperature will rise slowly and it is best to clean out the entire line. Under no condition should sterilizer be used unless temperature does rise to 250°-254° F. maximum.

On rare occasions, element in eliminator trap will fatigue, shut off too soon. Indication will be a definite lag in temperature rise. Maximum may drop to 250°-240° F. The only remedy is to secure a new trap element or an entirely new trap. In ordering either, specify by number on trap cover.

THE DOOR - At intervals of three months or oftener if there is an indication of binding, put a few drops of light machine oil on threads of stud on which door centers, and in oil hole of door collar--back of handwheel.

THE DOOR GASKET - When door fails to close steam tight under normal closing pressure, without straining handwheel, renew gasket which can be secured from out nearest source of supply. In removing old gasket, scrape groove in door frame clean. Gasket is cut to a tight fit in groove and must be forced in, a short section at a time, without stretching. Should gasket appear to be too long, do not cut it, but start over again, compressing short sections as inserted in groove, to take up full length. Coat face of gasket with powdered graphite mixed with water, or lacking graphite, use talcum powder with water, to prevent gasket from sticking to door under heat. Close door tight to seat gasket firmly.

AMERICAN WATER STERILIZERS
(ELECTRIC HEAT)
DIRECTIONS FOR USE

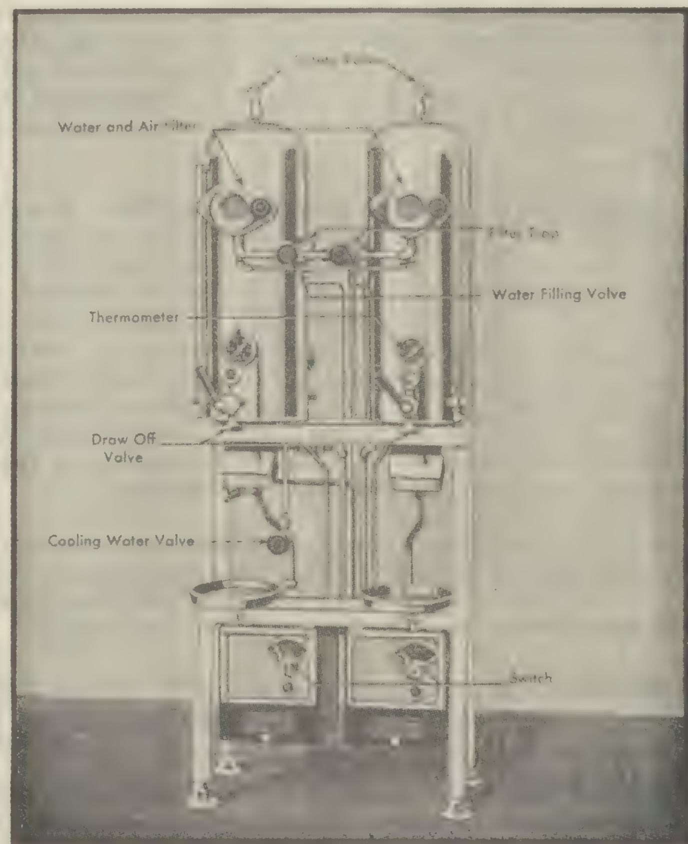
TO FILL RESERVOIR WITH WATER - Open "water filling valve" for reservoir to be filled. When water gauge indicates desired quantity, close "water filling valve" tight.

If water supply pressure is abnormally low and water flow slows down noticeably while filling, close "water filling valve" momentarily to permit air to escape from reservoir, then proceed with filling.

Change water filtering discs only when the rate of flow in filling becomes appreciably sluggish. Usually filter discs need to be replaced at intervals of three to six months. See directions for replacing discs.

TO TURN ON HEAT - Turn switch to "On" position for reservoir to be sterilized.

During sterilization water gauge is automatically sterilized, indicated by a film of water continuously flowing into top of gauge above the water level. Each water gauge fitting at top and bottom has a push button shut-off, for use only when gauge glass is broken. Normally these push buttons must be pushed all the way in, or pulled out, with a twisting motion, only to close off the gauge.



DURATION OF EXPOSURE - Time exposure as beginning when thermometer indicates 240° F.

AT CLOSE OF STERILIZATION

STEAM FLUSH "DRAW-OFF FAUCETS" - At close of the period of exposure, before turning off the heat, hold a wide mouth pitcher under the "draw-off faucet" and permit hot water and steam to flow vigorously for ten seconds or more, to cleanse the faucet and to blow out the connection into the reservoir.

TURN SWITCH OFF - Only after "draw-off faucet" has been steam flushed, turn switch to off position.

TO COOL WATER IN COLD (LEFT-HAND) RESERVOIR - When sterilization is complete, open "cooling water valve" and leave it open for about thirty minutes or until water has been cooled to desired range indicated by thermometer. Then be sure to close the "cooling water valve" tight.

RESTERILIZE EACH DAY - It is not good practice to allow sterilized water to stand more than twenty-four hours before resterilization.

MAINTENANCE SUGGESTIONS
AMERICAN WATER STERILIZERS
(ELECTRIC HEAT)

PRESSURE REGULATION - This sterilizer has automatic pressure regulation. We recommend operation with regulator set to maintain maximum temperature of 250°-254° F. as indicated by thermometer. The regulator is adjusted for this range at the factory. If adjustment becomes necessary, remove front cover of switch box which gives access to the large adjustment nut above regulating spring. Movement of nut clockwise increases; counter-movement decreases pressure.

LOW WATER CUTOUT - Sterilizer has low water cutout which functions as follows: Float in sterilizer rises and falls with water level. When sterilizer is nearly empty, circuit closes on float head, causing solenoid in switch box to trip heater circuit. Switch will snap off. Only when water has been replenished will switch remain on. Cutout mechanism should require no adjustment.

INSPECTION OF HEATER AND FLOAT - At intervals of six months (three nonths if water is very hard) inspect and clean heater and float. Open sterilizer drain valve until water is exhausted, then: *BEFORE INSPECTING ELECTRIC CIRCUITS, OPEN MAIN LINE SWITCH. DO NOT DEPEND UPON "PULLED FUSES"*.

First, remove heater cover and disconnect all terminals leading to switch box. Remove screws which hold heater head against gasket and take out heater. Clean out free scale and mud. If heater is coated with heavy lime deposits, soak element in 10%-20% muriatic acid only until scale softens for cleaning. Confine acid to heater elements with protection of terminals. Terminal studs and connectors having identical numbers to simplify reassembly and wiring diagram will be found on inside of switch box cover.

Second, remove float head from side of reservoir, handling it with care to avoid any distortion. Remove scale deposits, if necessary, by soaking in 10%-20% muriatic acid.

In replacing float head and heater, see that gasket is in perfect condition and test sterilizer under normal pressure to be sure that there are no leaks. Do not put sterilizer into service if there are any leaks.

AUTOMATIC GAUGE GLASS STERILIZATION - This system works on the principle of a coffee percolator. A small metal tube is attached to the source of heat so that a small volume of water is heated sufficiently in advance of the main body of water to force it through the tube, the other end of which leads to the top of the water gauge. This circulation, indicated by a film of water flowing into the top of the water gauge continues, vigorously at first, but slowing down as the water in the gauge and the water in the reservoir approach the maximum temperature. This circulation eliminates accumulation of sediment in the bottom of the gauge glass and subjects the water in the gauge so the same sterilizing effect as the water in the reservoir.

THE COMBINED WATER AND AIR FILTER - The filtering unit filters raw water as it flows to the reservoir and also filters all air drawn into the reservoir. While the reservoir is undergoing sterilization, the entire filtering system is automatically sterilized. The water filtering element consists of three removable filtering

discs held in place by a perforated metal cover in front, with hollow perforated metal separators between discs, against a perforated back wall which covers the air filtering unit consisting of tightly compressed non-corrosive metal wood.

The valve controlling raw water supply to the filter is a double action valve which when opened admits water to the filter and automatically closes the rear connection on the valve leading to the drain. When the valve is closed, water flow is shut off and the rear connection to the drain is opened. Then, should the valve leak slightly, leakage is conducted directly to the drain instead of the water reservoir. During sterilization steam from the reservoir passes through the filter to the drain and this flow continues until the filter (thermostatic) trap is heated when the trap closes, holding the entire filtering system under pure steam pressure as long as sterilization continues.

An air intake tube connects the air filtering compartment direct to the air vented waste. A ball check in the filter case prevents flow from the filter to the waste but admits air freely under the slightest back pressure as when water is withdrawn from the reservoir or when the sterilized reservoir cools down.

Sluggish flow of water from the reservoir may mean that the ball check in the air intake is adhering to the seat. To clean the ball check, remove the water filtering pads and take out the six screws which hold the air filtering element in place in the rear of the filter case. There are two extra tapped holes in the rim of this air filtering element for use in breaking the element loose from its gasket. Just insert two of the six screws in these holes and screw them in until the gasket lets go. This will expose the ball check for cleaning.

If water does not discharge from the filter case during sterilization, that will indicate clogging or fatiguing of the filter trap. Remove the top of the trap, clean the outlet and if necessary replace the trap element.

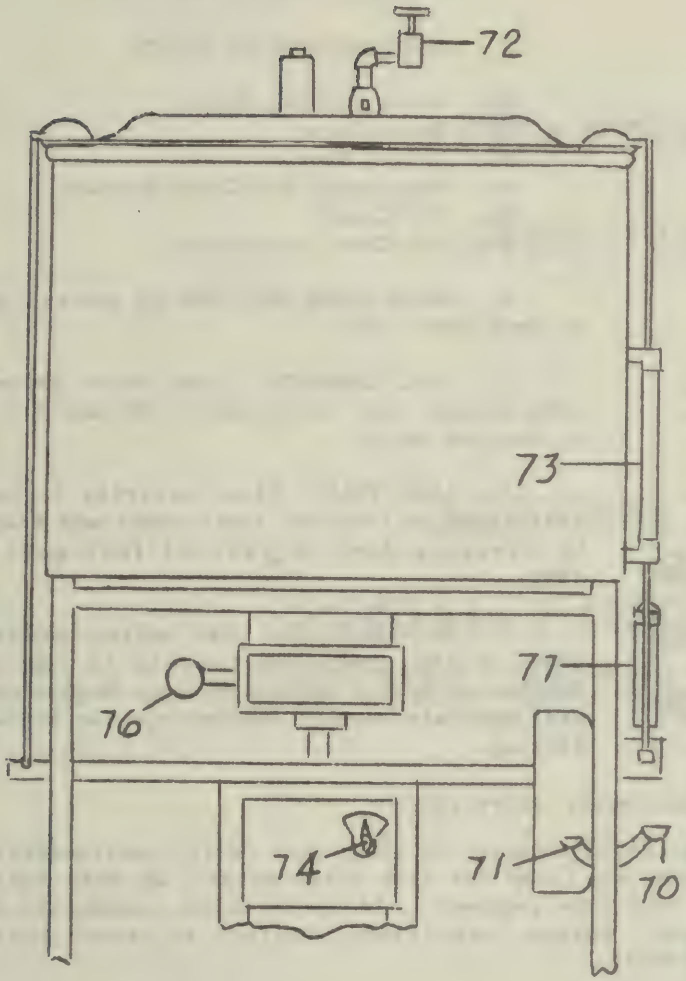
TO OPEN FILTER CASE - Turn cover handle counter-clockwise until door is free but donot attempt to open case except when sterilizer is cold or free from pressure.

TO REMOVE WATER FILTER UNIT - With filter case cover open, grasp two knurled guide pins at top. Slight effort will remove complete water filter assembly. Rear water filter disc may adhere to back wall. Wipe back wall clean before putting in new element.

TO ASSEMBLE NEW WATER FILTER UNIT - The rear plate has guide pins attached. Front side of this plate is the one on which guide pins are knurled. Place a fresh filter disc oneach side of this plate, then place front spacer (one having no guide pins) on top of renewed filter disc, on front side. Now place the third filter disc on top of this spacer and finally, place perforated cover plate on top of third filter disc. This completes assembly of unit. To replace unit in filter case, hold assembled unit by knurled ends of guide pins and insert unit in case so that guide pins enter locating holes in rear of case top. Close cover and tighten firmly with cover handle.

New water filter pads in cartons of 48 can be secured from nearest source of supply. Filter case gaskets, cut to exact size, are also available from stock.

OPERATING INSTRUCTIONS - UTENSIL STERILIZER



ELECTRIC HEAT
AUTOMATIC VAPOR REGULATOR
DESIGNATION OF PARTS

70. "RAISE" pedal
71. "LOWER" pedal
72. Water filling valve
73. Gauge glass
74. Switch handle
76. Waste valve
77. Oil Check

1. RAISE COVER - By four or five strokes of foot pedal (70).

2. LOAD TRAY - PLace articles to be sterilized on tray and lower into chamber by depressing pedal (71).

3. FILL STERILIZER - With waste valve (76) closed, open water valve (72) until gauge glass (73) indicates desired amount of water: then close (72).

4. TO STERILIZE - Turn switch handle (74) so that indicator points to "ON". When water boils, Automatic Vapor Regulator will maintain correct temperature for sterilizing.

5. TO DRAIN STERILIZER - Open waste valve (76).

KEEP THE STERILIZER CLEAN - Scrub interior of a sterilizer daily, particularly the heater tubes, with a stiff brush, and flush out with clean water. Be sure that pocket under heater tubes is kept free from sediment. If heater tubes accumulate a perceptible coating of lime (scale), scrape them clean. Failure to remove this coating of lime will result in burnouts.

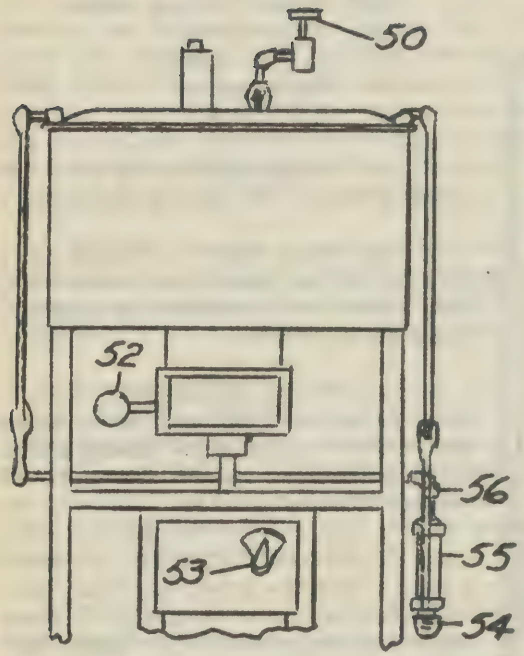
POLISH NICKEL SURFACES - Use any good metal or silver polish to keep polished surfaces free from tarnish. Do not use polish on stand or lift arms. Avoid use of alcohol.

EXPLANATORY - When switch is turned on to "ON" signal lamp in switch handle will burn continuously. If lamp does not light up or if sterilizer does not heat up when switch is turned to "ON", check to find what is wrong. If water reaches a level below bottom of tray when heat is on, switch handle (74) will snap back to "OFF", cutting off the heat. Fresh water should then be added and the switch turned on again.

TO PREVENT COVER SLAMMING - Maintain oil level in oil check (77) by first removing knurled cap and then adding medium motor oil to required level.

OPERATING INSTRUCTIONS
INSTRUMENT STERILIZER

ELECTRIC HEAT
AUTOMATIC VAPOR REGULATOR



DESIGNATION OF PARTS

50. Water Filling Valve
52. Waste Valve
53. Switch Handle
54. Foot Pedal and Cover Release
55. Oil Check
56. Oil Check Adjustment

1. RAISE COVER AND TRAY by pressing on foot pedal (54).

2. FILL CHAMBER - With waste valve (52) closed, open water valve (50) and fill to desired depth.

3. LOAD TRAY - Place articles to be sterilized on tray and lower cover and tray by pressing down on rear of foot pedal (54).

4. TO STERILIZE - Turn switch handle (53) so that indicator points to 'ON'. When water boils, Automatic Vapor Regulator will maintain correct temperature for sterilizing.

5. TO DRAIN STERILIZER - Open waste valve (52).

6. KEEP THE STERILIZER CLEAN - Scrub interior of sterilizer daily, particularly the heater tubes, with a stiff brush and flush out with clean water. Be sure that pocket under heater tubes is kept free from sediment. If heater tubes accumulate a perceptible coating of lime (scale), scrape them clean. Failure to remove this coating of lime will result in burnouts.

POLISH NICKEL SURFACES - Use any good metal or silver polish to keep surfaces free from tarnish. Do not use polish on painted surfaces. Avoid use of alcohol.

EXPLANATORY - When switch is turned to "ON" signal lamp in switch handle will burn continuously. If lamp does not light up or if sterilizer does not heat up when switch is turned to "ON", check to find what is wrong. If water reaches a level below bottom of tray when heat is on, switch handle (53) will snap back to "OFF", cutting off the heat. Fresh water should then be added and the switch turned on again.

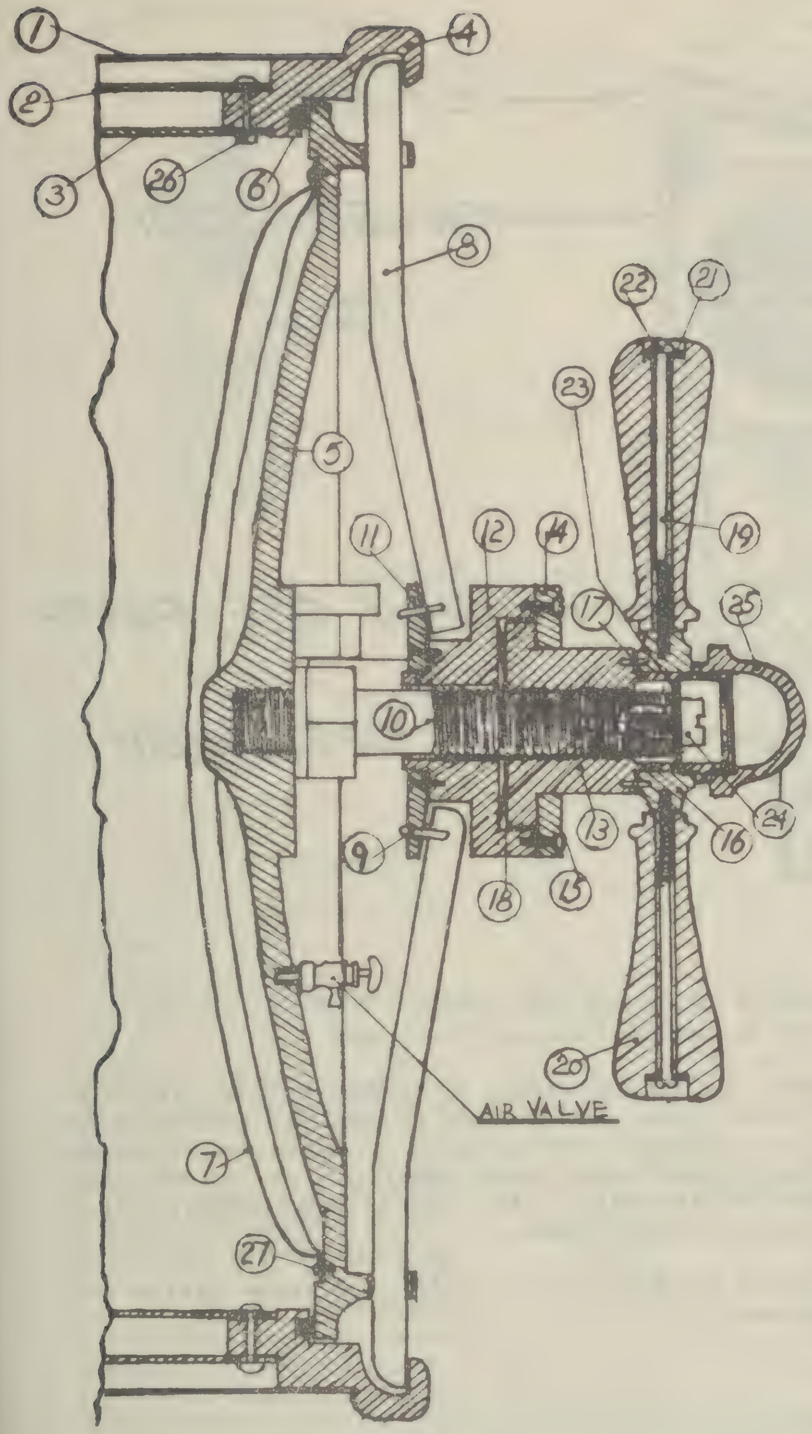
OIL CHECK ADJUSTMENT - To regulate cover closing, turn adjusting nut (56) to right or left until desired cushioning effect has been obtained. Renew oil in (55) when needed - use medium oil.

CHAPTER II

STERILIZERS

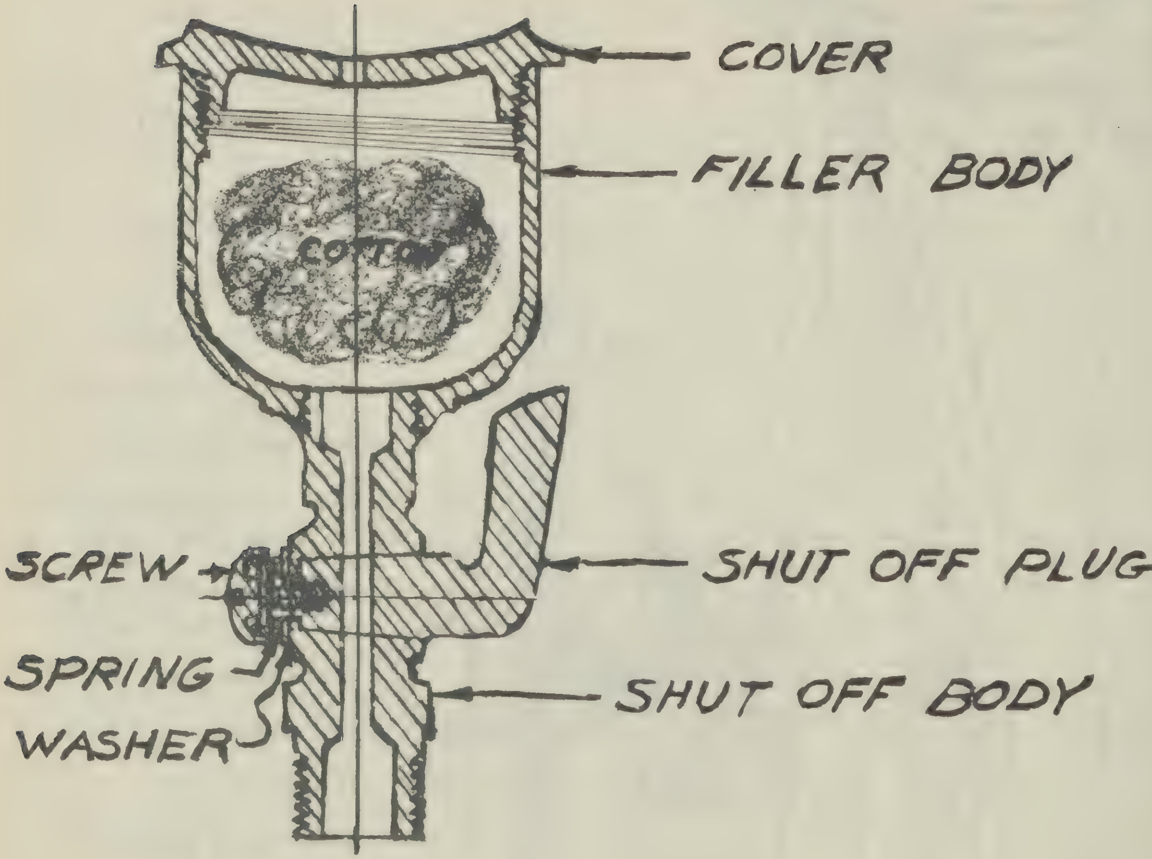
SECTION 16

SPECIAL PARTS SECTION
- HOSPITAL SUPPLY STERILIZER -



CROSS SECTION THROUGH DOOR MOVEMENT
OF DRESSING STERILIZERS

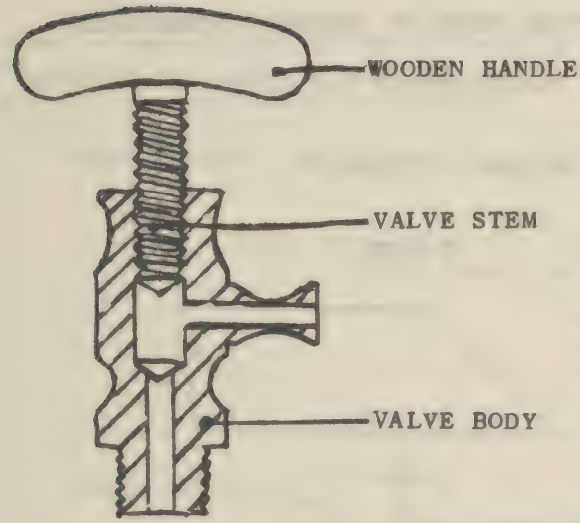
1. Finishing Jacket
2. Outer Shell
3. Inner Shell
4. Chamber Collar
5. Door
6. Rubber Gasket
7. Door Baffle
8. Steel Finger
9. Finger Swivel Pin
10. Main Stud Screw
11. Finger holding casting (lower part)
12. Finger holding casting (upper part)
13. Driving Nut
14. Sleeve
15. Screw
16. Handle Casting
17. Guide Pin
18. Friction Spring
19. Handle Stud
20. Wooden Handle
21. Handle Washer
22. Handle Screw
23. Stop Washer
24. Screw for Stop
25. Finishing Cap Nut
26. Collar Rivets
27. Baffle Screws
28. Air Valve



CROSS SECTION OF BRASS OIL CUP NO. 6
Vacuum breaker as used on Dressing Sterilizers

PURPOSE OF VACUUM BREAKER - The Vacuum breaker is located in front of sterilizer door, or on top of sterilizer. When sterilization is completed and vacuum for drying has been drawn, sterilizer door could not be opened unless vacuum is broken. This is accomplished by opening shut off plug thereby equalizing the outside pressure with the inside pressure of the sterilizer. Air which is drawn into sterilizer is forcibly filtered by cotton plug in filler body.

SERVICE HINTS (Maintenance and Repair) - Put dry and fresh cotton into filler body before every sterilization.



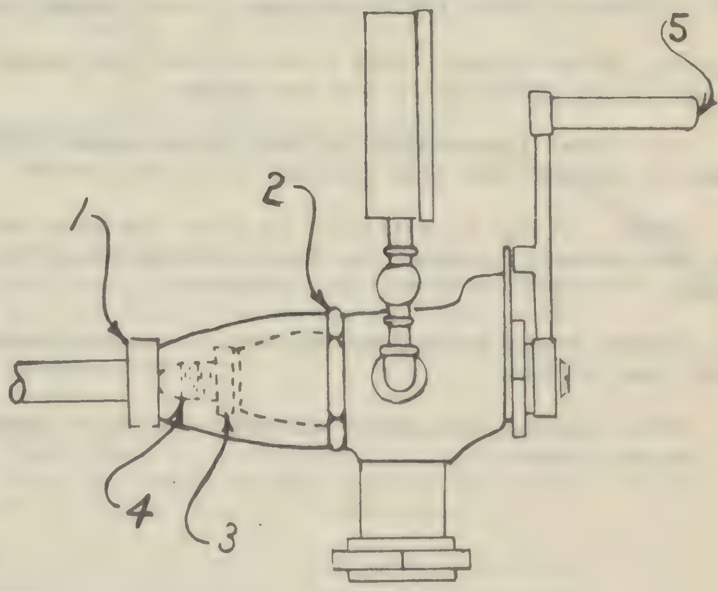
PURPOSE OF AIR VALVE - Air valve is located in front of door of dressing sterilizer. As as additional safeguard to guarantee that chamber of sterilizer has been completely freed of air, this valve should be kept slightly open during time of sterilization. Steam traps have the purpose of eliminating the air in the sterilizer chamber, however, since they are not unfailing in their operation, the air valve provides added safety for complete removal of air. Successful sterilization depends upon complete ellimination of air from the sterilizer chamber.

SERVICE HINTS (Maintenance and Repair) - No service is required for this valve.

INSTRUCTION FOR SETTING VACUUM DEVICE

PARTS

1. Outer Lock Nut.
2. Housing.
3. Inner Lock Nut.
4. Vacuum Regulator.
5. Lever on 4-way valve.



A. Loosen Outer Lock Nut #1.

B. Unscrew Housing #2 and push it back out of the way.

C. Loosen Inner Lock Nut #3, and unscrew to the end of the vacuum regulator.

D. Turn Vacuum Regulator #4 to the left (when standing in front of sterilizer) so that it will go into the 4-way valve as far as possible without applying pressure. Then turn three complete revolutions to the right, thus withdrawing it from the 4-way valve. This is approximately the correct position for drawing proper vacuum. Adjust the vacuum by moving Lever #5 to Vacuum and if the correct vacuum is not obtained, then either turn vacuum regulator #4 either to the right or left, as may be necessary, until the correct vacuum is attained. After this is done, tighten Inner Lock Nut #3, reset and tighten Housing #2 and Outer Lock Nut #1.

INSTRUCTIONS FOR REPLACING GASKET FOR DOOR OF DRESSING STERILIZER

1. Remove worn out gasket completely, making certain that groove of sterilizer is free of any adhering particles.

2. Cut one end of gasket at an angle as shown in Figure 1.

FIGURE 1

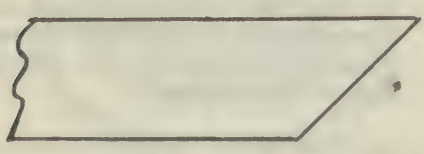


FIGURE 2

FRONT FACE OF GASKET

3. Insert the angle cut end of gasket into the groove at the top; press firmly in position with the thumb of one hand while stretching and gradually inserting the remainder of the gasket with the other hand.

4. Carefully cut the end of gasket at an angle to match the angle of the other end to effect a tight joint; improper fit will cause leakage. (Figure 2)

5. Place a small wood block against the gasket and tap with a mallet all around to set gasket fully into the groove.

6. Smear the outside surface of the gasket with a mixture of graphite and water to prevent door from sticking to it when heated.

NOTE: It may be difficult to close the door the first time after inserting the new gasket, but once the door is closed and the gasket sets fully into the groove, this difficulty will be eliminated.

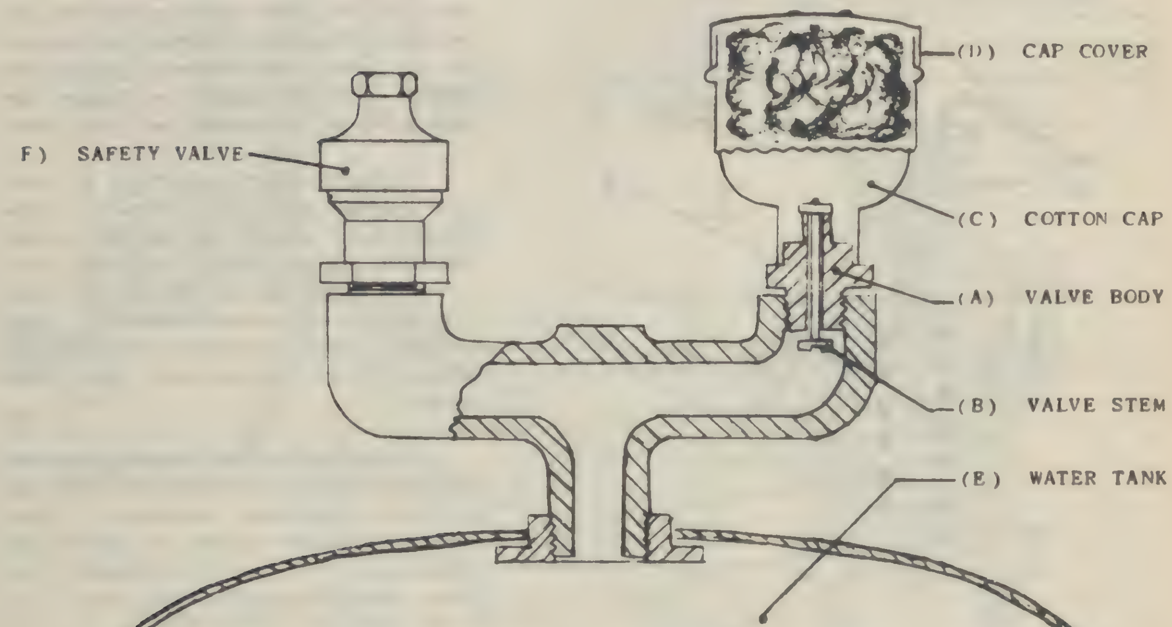
Gasket should be replaced as often as is necessary to maintain steam and vacuum tight door closure.

When ordering new gasket specify the serial number appearing on the nameplate of the sterilizer.

SAFETY VALVE - Purpose of Safety Valve: This valve will automatically release steam at approximately 22 lbs. pressure or at two lbs. over actual working pressure. Valve will only operate when pressure reducing valve fails to keep the tank pressure at the preset pressure of 20 lbs.

SERVICE HINTS - Maintenance and Repair: See Detail Sheet for Safety Valve.

Three way casting with safety Valve and Air filter
(Intake Valve) for Water Sterilizers



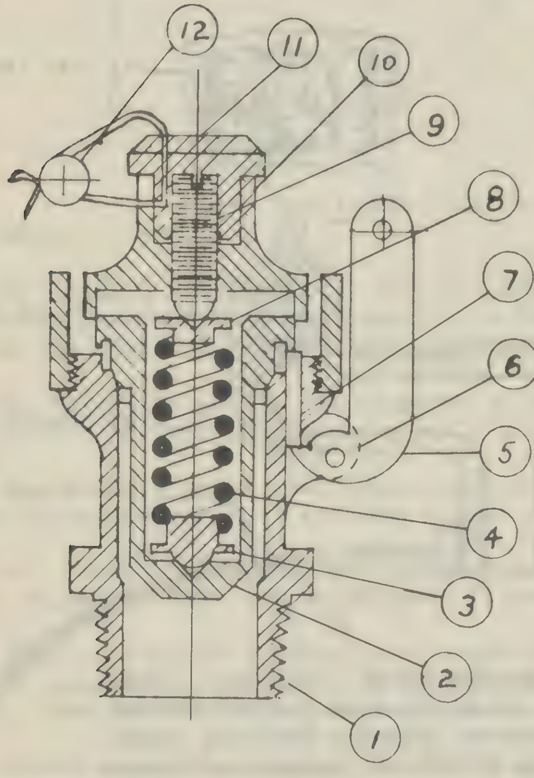
AIR FILTER AND AIR INTAKE VALVE - Purpose: When water is filled into tank, air in the tank escapes through air valve A. As soon as internal preesure develops inside of tank, valve stem B will be lifted and automatically seal tank against air from outside.

After sterilization is completed air intake valve will open by itself. When water is drawn from the tank faucet air will rush into the tank through air valve being forcibly filtered by cotton plug in cotton cap C.

SERVICE HINTS (Maintenance and Repair) - Refill cotton cap C with fresh and dry cotton before every sterilization. If air intake valve should leak, remove cotton cap C and unscrew valve body A. Regrind valve stem B by means of screw driverl Use grinding compound grade A only.

SAFETY (POP) VALVES - On pressure sterilizers they are for the purpose of releasing excess pressure within the sterilizer. They are safety devices, as the name indicates, and should, therefore, be frequently inspected and tested.

Safety valves should be tested daily by simply raising the lever arm of the valve when there is pressure in the sterilizer to see if steam will escape freely through the valve. When the arm is released, the valve should close promptly and tightly.



1. Body
2. Cup
3. Lower Spring Plate
4. Spring
5. Lever
6. Machine Screw
7. Lift Pin
8. Upper Spring Plate
9. Pressure Screw
10. Cap
11. Locknut or Jam Nut
12. Seal

The safety valves are set and sealed at the factory to release at about 22-25 lbs, pressure in the sterilizer. The setting should not be changed unless checked by means of an accurate steam pressure gauge. If necessary to change the adjustment, proceed as follows:

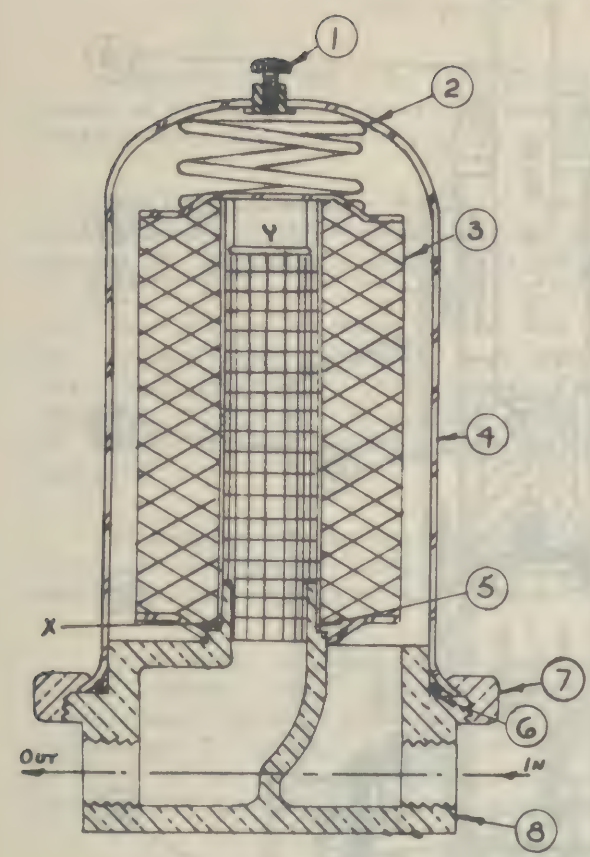
Remove lock nut #11 - this will expose pressure screw #9. The pressure at which the safety valve releases is determined by the tension of spring #4 which is controlled by pressure screw #9. Lock nut #11 locks pressure screw #9 in place after adjustment has been made.

To adjust after having removed lock nut #11 turn down on pressure screw to increase pressure. Turn up on pressure screw to decrease pressure. After adjustment has been made replace lock nut.

If the safety valve leaks steam continuously, the trouble is usually caused by dirt or scale lodging in the valve seat, preventing the valve disc from seating properly. When this occurs, the valve should be removed from the sterilizer, taken apart and carefully cleaned.

DIRECTIONS FOR CLEANING VALVE SEAT - Remove lock nut and unscrew cap #10 from cup #2. Clean valve disc and seat. Reassemble and adjust.

If the valve leaks because of a worn seat or disc, they may sometimes be successfully ground in with a fine valve grinding compound.



NO.	PART
1.	Air Vent
2.	Top Tube Seat Plate Assembly
3.	Honeycomb Filter Tube
4.	Filter Shell
5.	Bottom Seat Plate (Part of Base)
6.	Gasket
7.	Lock Ring
8.	Base

FULFLO WATER FILTER MODEL 5MW
WITH
HONEYCOMB FILTER TUBE 1723CT-1

ASSEMBLY

1. Place Gasket on Base as shown.

2. Place Honeycomb Filter Tube on Bottom Seat Plate, making sure that Tube is over centering post "X" to form a tight seal.

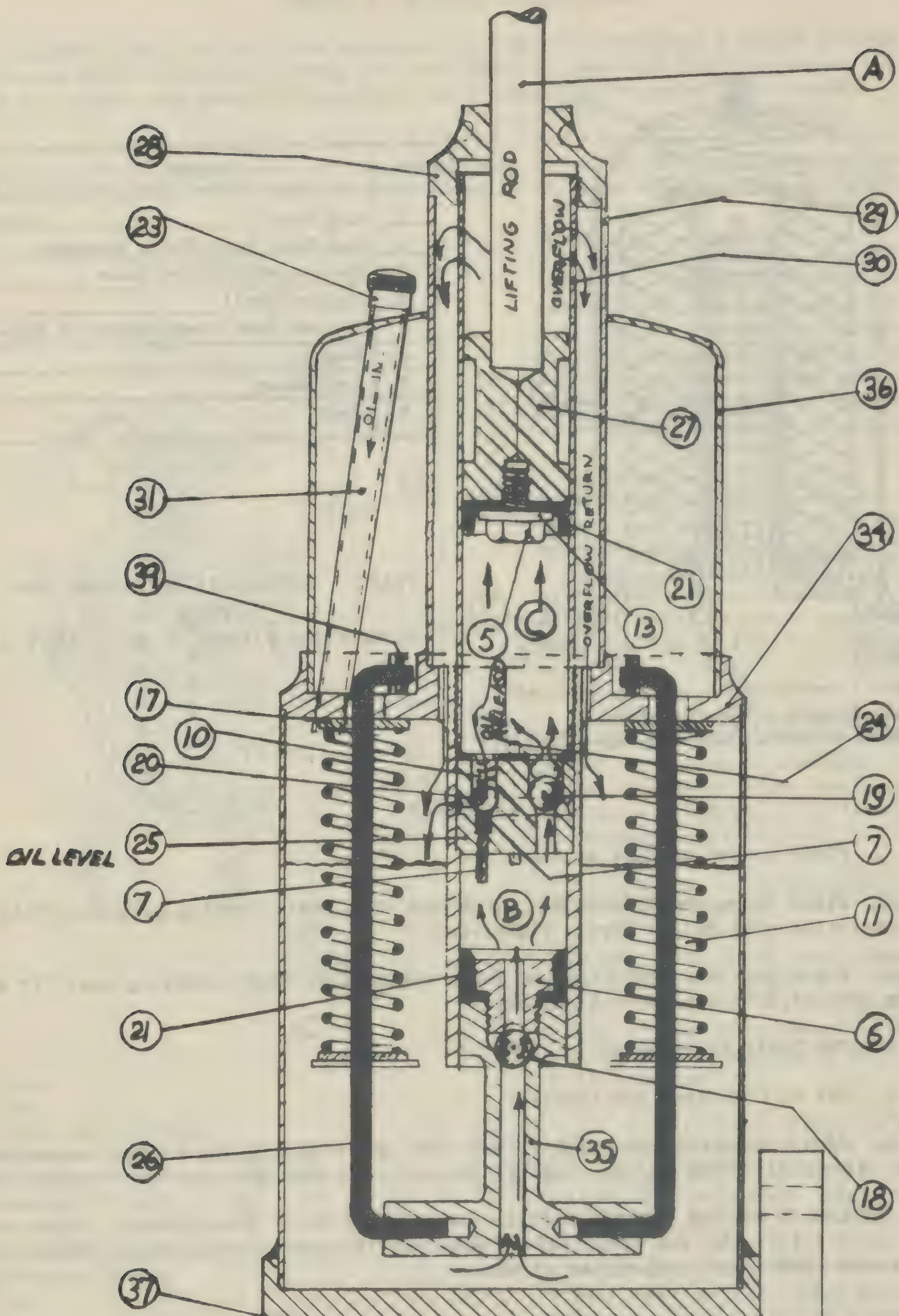
3. Place Top Tube Seat Plate on Tube, making sure that centering post "Y" goes inside core of Tube to form a tight seal.

4. Put Shell on as shown.

5. Put on Lock Ring and tighten.

6. After changing Honeycomb Filter Tube and reassembling Filter as outlined above, leave Air Vent (1) open until liquid runs out, to release trapped air.

PURPOSE OF FILTER - Water Filters are used on Water Sterilizers. Their purpose is to filter the raw water before entering the sterilizing tank. Filter will only remove mechanical impurities of water.



CROSS SECTION THROUGH OIL PUMP AS USED ON UTENSIL STERILIZER

OIL PUMP FOR UTENSIL STERILIZER

PURPOSE OF PUMP - To lift conveniently and noiselessly utensil tray and cover of Utensil Sterilizer, to keep tray suspended in any position and to lower utensil tray into sterilizer while cover is closing.

HOW PUMP OPERATES - When foot pedal 39 is operated lower pump plunger 35 will move upwardly in the cylinder chamber B. Counter-action springs 11 will pull back plunger 35, then pump plunger 35 is in the position for the following stroke.

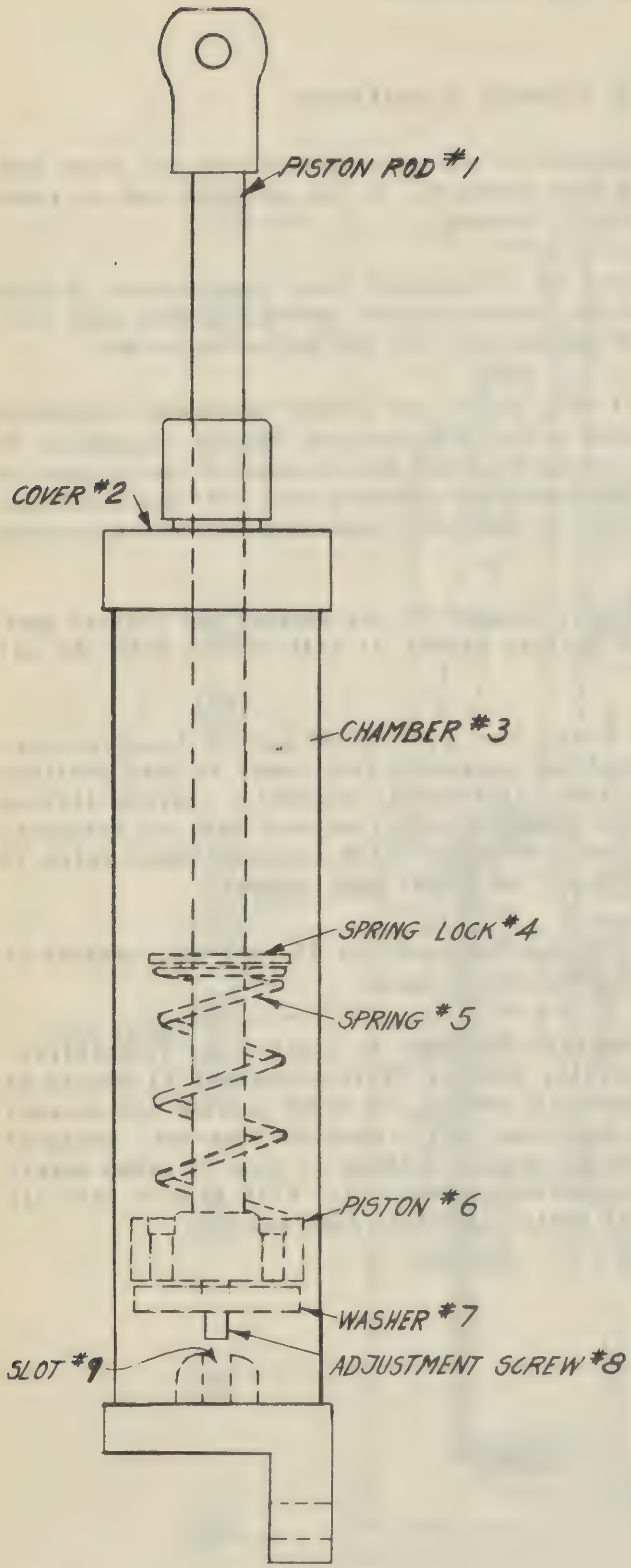
When plunger 35 moves upward, oil will enter into chamber B through checkball 18. By continuing to operate foot pedal oil will be pressed through checkvalve 19 into upper chamber C. Oil, however, cannot return into chamber B on account of checkball 19 and 20. If pumping is continued oil pressure will lift upper plunger 27 thereby raising lifting rod A which is directly connected with tray raising mechanism.

If pumping is continued though upper plunger 27 has reached its highest position, oil eventually leaking through leather washer 21 will return into the oil reservoir by way of overflow chamber.

Foot pedal is so designed that lower pump plunger 35 cannot touch release pin 7. However, when tilting foot pedal and operating foot pedal in that position pump plunger 35 will move up an additional distance in chamber B thereby lifting release pin 7. If this happens oil from chamber C will flow back into oil reservoir by means of way through oil check 20 and a borehole which connects check valve 20 with the oil reservoir. Accordingly lifting rod A will move downward.

If tilting of foot pedal is discontinued, pump plunger 35 will only operate as described before and lifting rod A will move upward again.

SERVICE HINTS (Maintenance and Repair) - The pump is practically troublefree. If pump should not operate satisfactorily, plunger leather washers 21 should be examined and eventually replaced. Checkballs 18, 19, 20 might corrode and prevent tight closure of checkvalves. In that event new balls should be inserted. Seats of checkvalves should be cleaned and freed of foreign matters if pump is taken apart. For best results use only first quality medium machine oil. Fill 1½ pint into oil reservoir through filler pipe 31. Close filler pipe with pipe cap 23.



INSTRUCTIONS FOR ADJUSTING OIL CHECK

INSTRUCTIONS FOR ADJUSTING OIL CHECK

1. Detach Piston Rod #1 from sterilizer.

2. Unscrew cover #2. Fill chamber #3 with medium machine oil up to 3/4" below edge of tubing.

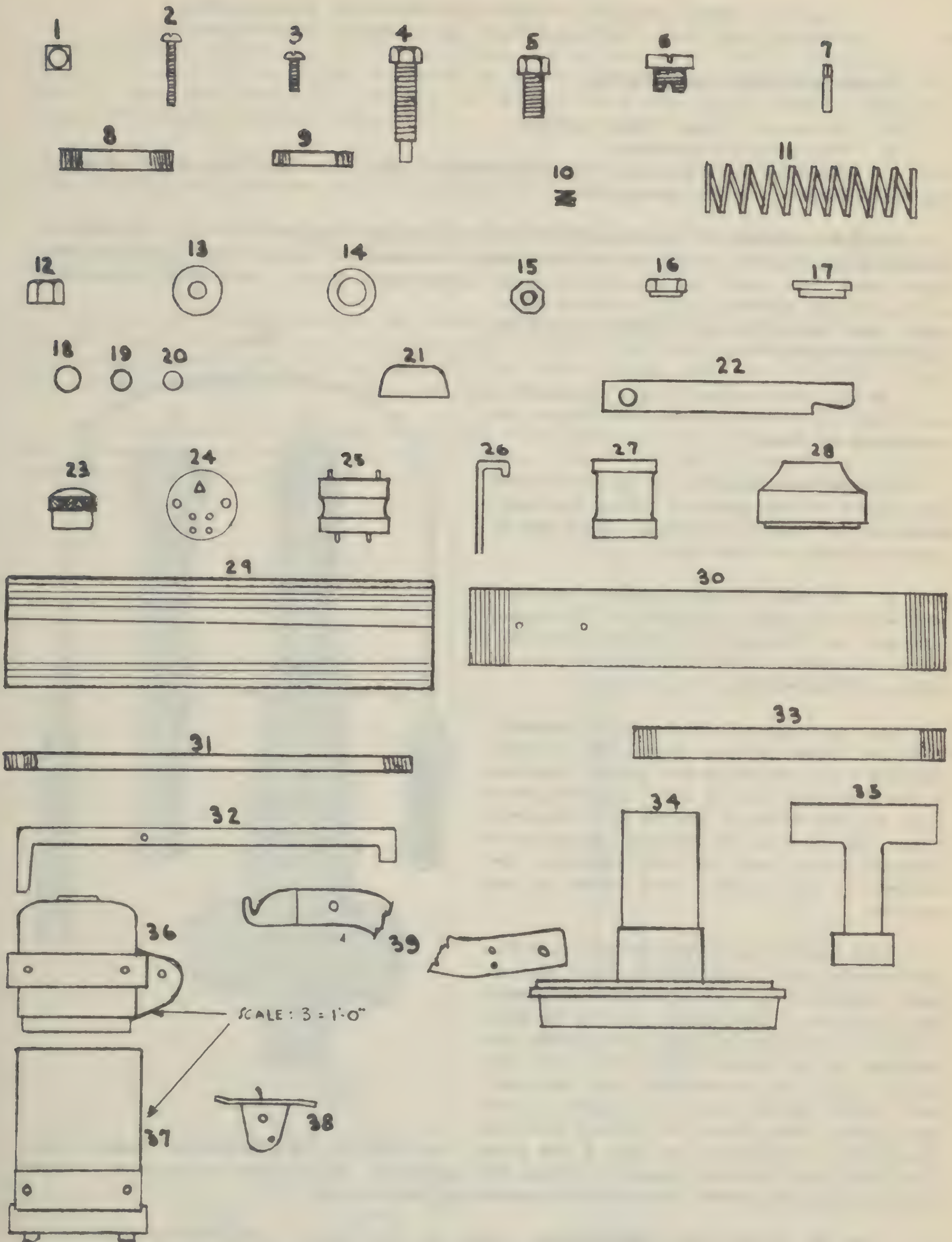
3. Replace cover #2 on oil check and tighten up.

4. Force Piston Rod #1 as far as it will go. Turn Piston Rod #1 until adjustment screw #8 sets into slot #9. You will feel a click when this occurs.

5. Turn Piston Rod #1 slightly to the left or right as may be necessary. (You may have to use a wrench or a pair of pliers in so doing). If cover drops too quickly, turn Piston Rod #1 to the right.

6. Re-attach Piston Rod #1 to the sterilizer body and open and close cover again. If the cover still comes down too slowly or too quickly, repeat the above operations until proper adjustment is made.

EXPLANATION - If the adjustment screw #8 sets into slot #9, turning the Piston Rod #1 to the left increases the space between Piston #6 and Washer #7. This permits the oil to pass through more quickly. When Piston Rod #1 is turned to the right, the space is decreased so that the oil passes through more slowly.



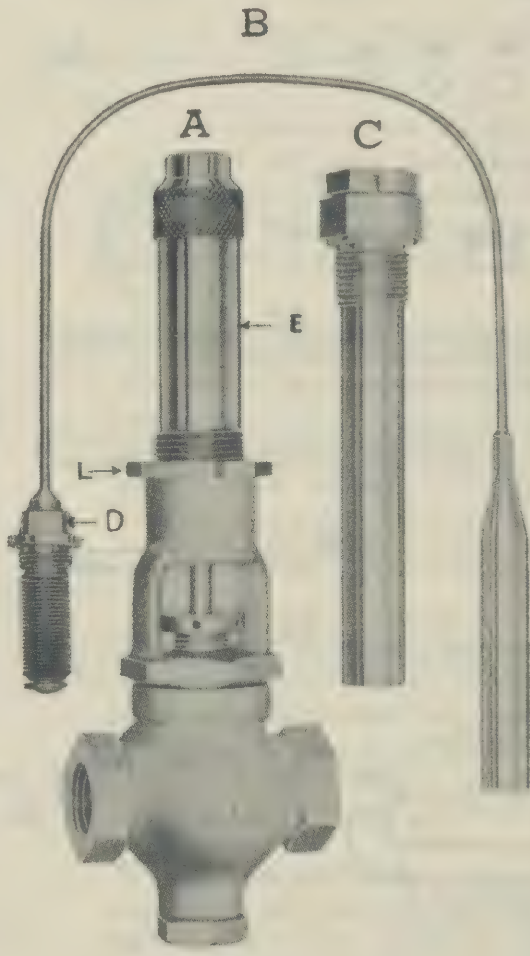
PARTS FOR OIL PUMP

EXCESS VAPOR CONTROL VALVE NON-PRESSURE STERILIZERS
INSTRUCTIONS FOR INSTALLATION, ADJUSTMENT AND OPERATION

THERE ARE THREE MAIN PARTS

A. Automatic Steam Valve proper.
B. Thermostatic Element.
C. Threaded Bulb Casing, for insertion of the bulb into the space of which the temperature is to be controlled.

GENERAL METHOD OF INSTALLATION - The Automatic Steam Valve (A) can be installed either in the steam supply line near to where it enters the apparatus, or, where coils are used, in the outlet pipe (condensate line). For small apparatus such as steam tables, urns, sterilizers, etc., the valve is preferably placed in the steam supply line.



Place the valve always in such a position that the arrow indicates the direction of flow.

The bulb-casing (C) is inserted into the liquid or air space of which the temperature is to be controlled. This can be done in either of two ways:

a. In case of thick-walled vessels, and wherever the presence of flanges, bosses, or fittings make this possible, screw the casing directly into the side or bottom of the vessel.

b. In case of thin-walled vessels, such as steam tables, dishwashers, urns and the like which do not permit the use of method (a), cut a 3/4" smooth round hole in the side or bottom and securely clamp the casing in place by means of a locknut and a pair of lead washers, one washer on the inside, the other on the outside.

Not until the valve itself and the bulb-casing are installed in their permanent locations is the thermostatic element put in place. The safest way to do this from the standpoint of protecting the bellows is to remove sleeve (E) from the valve, slip the sleeve over the bellows, and screw swivel nut (D) tightly into position. Then place the sleeve back on the valve, screwing it in only a few turns, and lock it in place with locknut (L). Thus the valve is wide open, allowing the apparatus to heat up as fast as is possible during adjustment for desired operating temperature.

HOW TO ADJUST FOR TEMPERATURE - Turn on the steam. The valve being wide open, as indicated in the preceding section, heating up of the apparatus will be very rapid. When the temperature at which it is desired to set the valve is reached,

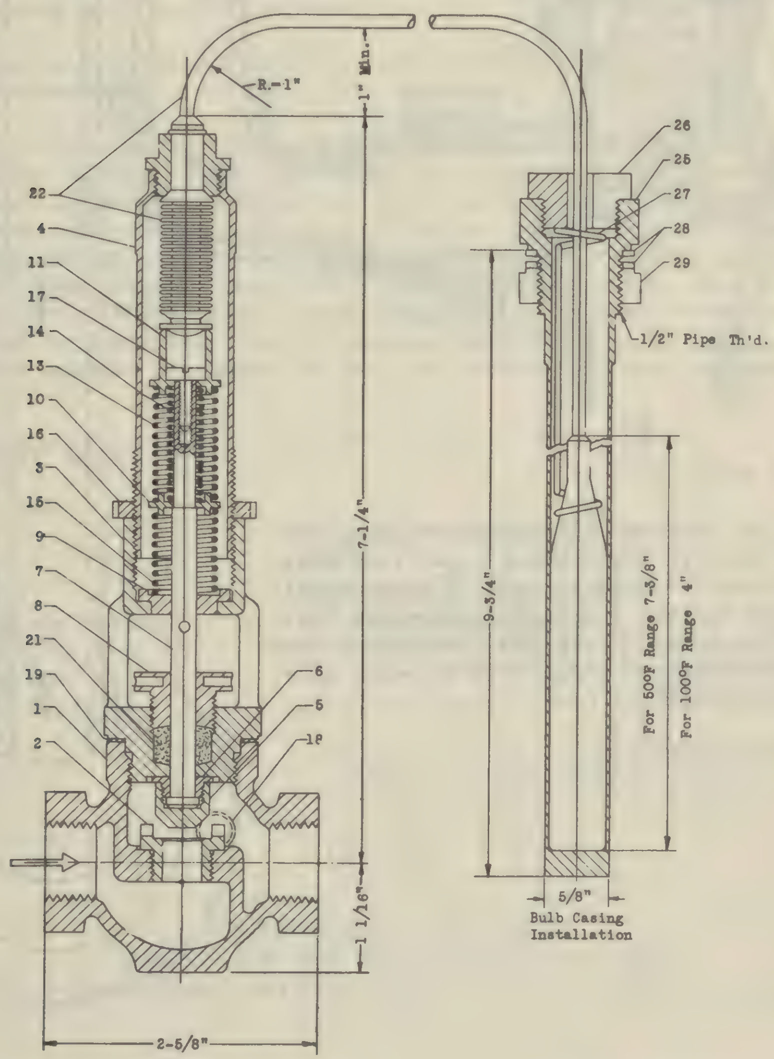
quickly loosen locknut (L) and screw sleeve (E) in until the flow of steam or condensate stops. (This can be observed by removing test plug in the side of the valve). Turn the sleeve (E) back just far enough for a very slight flow to start up again, and finally tighten locknut (L).

The valve is now set and will operate without attention, opening and closing automatically in accordance with the demand for heat.

Should a further readjustment of the temperature setting be desired at any time, remember that turning sleeve (E) inward lowers the temperature, turning it outward raises the temperature.

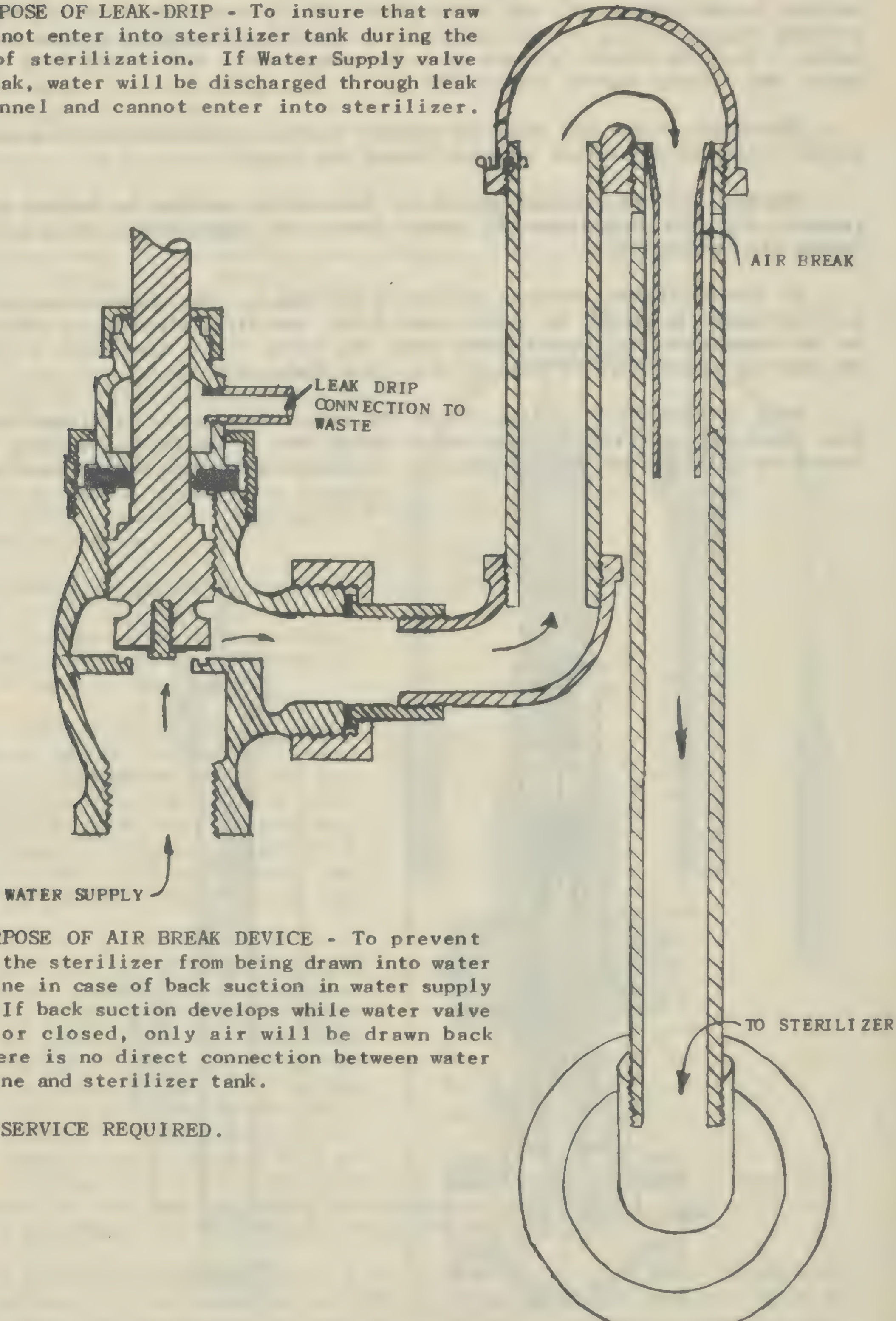
If the difference between the valve setting and the temperature of the controlled vessel is great, the valve opens fully, admitting steam up to full capacity. As the temperature difference grows less, the valve closes gradually, so that, when the desired temperature is reached, the steam shuts off.

When necessary the packing around the valve stem can be tightened by screwing down gland (K). Caution is required in doing this. Too tight a packing is apt to interfere with the smooth and accurate functioning of the temperature regulator.



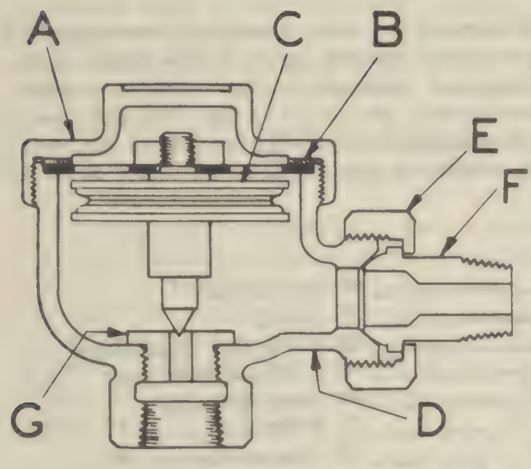
WATER SUPPLY VALVE WITH LEAK DRIP AND AIR BREAK

PURPOSE OF LEAK-DRIP - To insure that raw water cannot enter into sterilizer tank during the process of sterilization. If Water Supply valve should leak, water will be discharged through leak drip channel and cannot enter into sterilizer.



PURPOSE OF AIR BREAK DEVICE - To prevent water in the sterilizer from being drawn into water supply line in case of back suction in water supply system. If back suction develops while water valve is open or closed, only air will be drawn back since there is no direct connection between water supply line and sterilizer tank.

NO SERVICE REQUIRED.



PARTS LIST

Symbol	Name
A	Cap
B	Gasket
C	Diaphragm Assembly
D	Body
E	Union Nut
F	Union Nipple
G	Seat

PURPOSE - The function of this trap is to hold steam in a chamber or heating coil until the useful heat of this steam hhas been given up. At the same time the trap automatically discharges water of condensation, air and other non-condensable gases into the return piping.

OPERATION - The trap is entirely automatic in operation and requires no manual regulation.

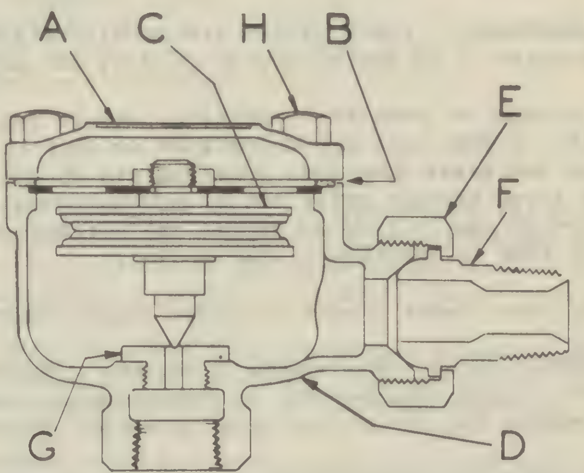
THERMOSTATIC STEAM TRAP
Webster 3/8" No. 780-2
Cross Section through Steam Trap Type 780-2
as used on Direct Steam Sterilizer

ADJUSTMENT - The diaphragm assembly of trap (thermostatic element) is factory-adjusted and cannot be repaired elsewhere. Complete new diaphragm assemblies including pointed valve piece are required when replacement is necessary.

SERVICE HINTS - To secure long life and efficient operation of this thermostatic trap keep working pressures below 60 lb. per sq. in. Once or twice a year remove cap and diaphragm assembly so that inside of body and valve seat can be cleaned. Simply wipe out interior with a rag or waste dipped in kerosene. Examine seats for nicks or excessive wear on one side, either of which may result in leakage of steam if the pointed valve piece cannot seat tightly. Worn or nicked seats should be replaced. Where valve pieces are excessively worn, complete new diaphragm assemblies must be installed. After removing cap, a new gasket may have to be used. CAUTION - Never unscrew or remove the cap and interior of this trap while it is hot.

PARTS LIST

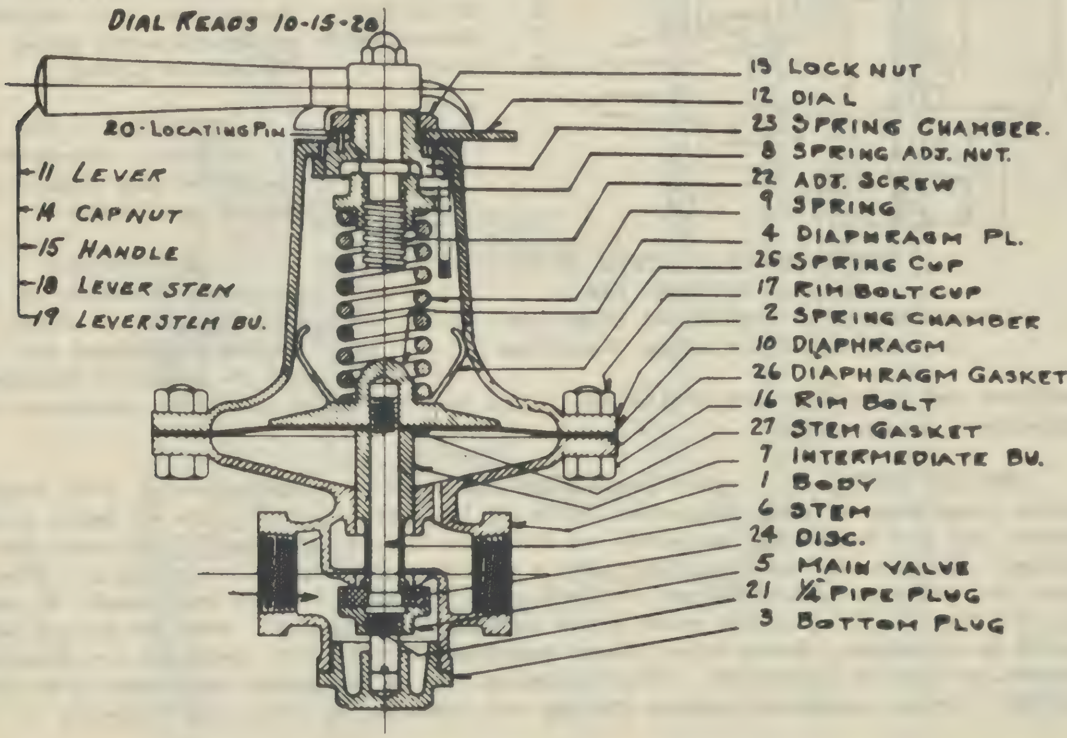
Symbol	Name
A	Cap
B	Gasket
C	Diaphragm Assembly
D	Body
E	Union Nut
F	Union Nipple
G	Seat
H	Cap Screw



THERMOSTATIC STEAM TRAP
Webster 1/2" No. 782-2 and 3/4" No. 783-2
Cross Section through Steam Trap Type 782-2 as used on Direct Steam Sterilizer

STEAM PRESSURE REDUCING VALVE TYPE 39Y14
1/2" with Dial and Handle as used on Dressing Sterilizers

HOW VALVE OPERATES - These valves are designed to take steam at average 75# pressure and by action of compression on adjustment spring part 9 the main valve part 5 is forced off the seat allowing steam to pass through to low pressure side. As soon as sufficient pressure has been accumulated, it is felt up through small port to underside of diaphragm part 10. This diaphragm has sufficient area to overcome spring action and close main valve. The point at which it overcomes same is controlled by spring compression.



ADJUSTMENT - These valves are usually preset and only require relocation of lever pointer 11 to the reading on dial 12 for adjustment.

In event of complete resetting, remove cap nut 14 from 22 and pick up lever complete. Loosen lock nut 13 and pick up dial 12. Relocate dial 12 to good reading position and press down over locating pin 20 and tighten lock nut 13. Allow small flow of steam through valve and by putting lever pointer on upside down the adjusting screw 22 can be rotated to get 15# setting on reduced line. Put lever pointer on right side up pointing to 15# on dial.

All other moves revert to preset as per first paragraph.

SERVICE HINTS (Maintenance & Repair) - Build up of reduced pressure even with adjusting spring backed off to lowest point indicates leakage by disc part 24. Steam leakage out around dial area indicates fracture of diaphragm part 10.

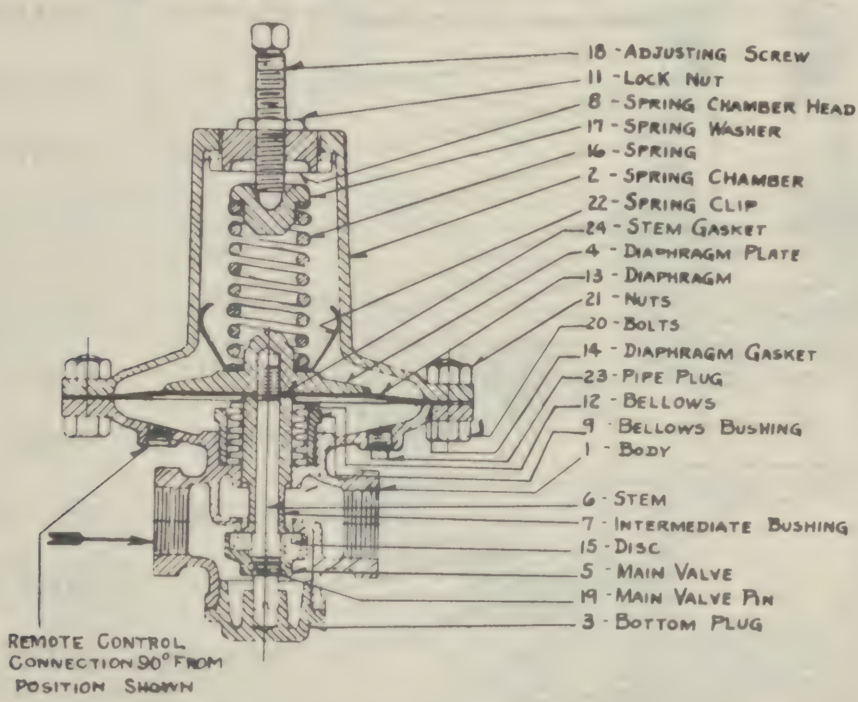
To dismantle remove dial mechanism as covered under adjustment, depress head part 23 and turn 60 degrees either way and pick head up through slots. Remove rim bolts part 16-17 and take off chamber and inspect spring assembly.

Remove bottom plug part 3 and hold square head of main valve part 5. Unscrew diaphragm plate 4 and remove all parts through bottom opening. Slide intermediate

bushing part 7 off stem and replace disc 24 with Jenkins #119A or equal material. Replace all gaskets with long fibre asbestos stock and reassemble. It will be found more permanent to soak disc 24 in hot water before final assembly to assure tightness. Tighten stem assembly firmly but do not crack disc by overload.

STEAM PRESSURE REDUCING VALVE TYPE 39Y17
For Remote Control as used on Water Sterilizers

HOW VALVE OPERATES - These valves are designed to take steam at average 75# pressure and by action of compression on adjustment spring part 16 the main valve part 5 is forced off the seat allowing steam to pass through to low pressure side. As soon as sufficient pressure has been accumulated in the system, it is felt back along the remote control line to diaphragm chamber. This diaphragm has sufficient area to overcome spring action and close main valve. The point at which it overcomes same is controlled by spring compression which is adjustable by adjusting screw part 18.



ADJUSTMENT - These valves are furnished with an adjusting screw part 18 held at set point by lock nut part 11. To vary pressure loosen lock nut and turn adjusting screw to the right to increase or to the left to decrease. No other adjustments are available. Always tighten lock nut to prevent change by variation.

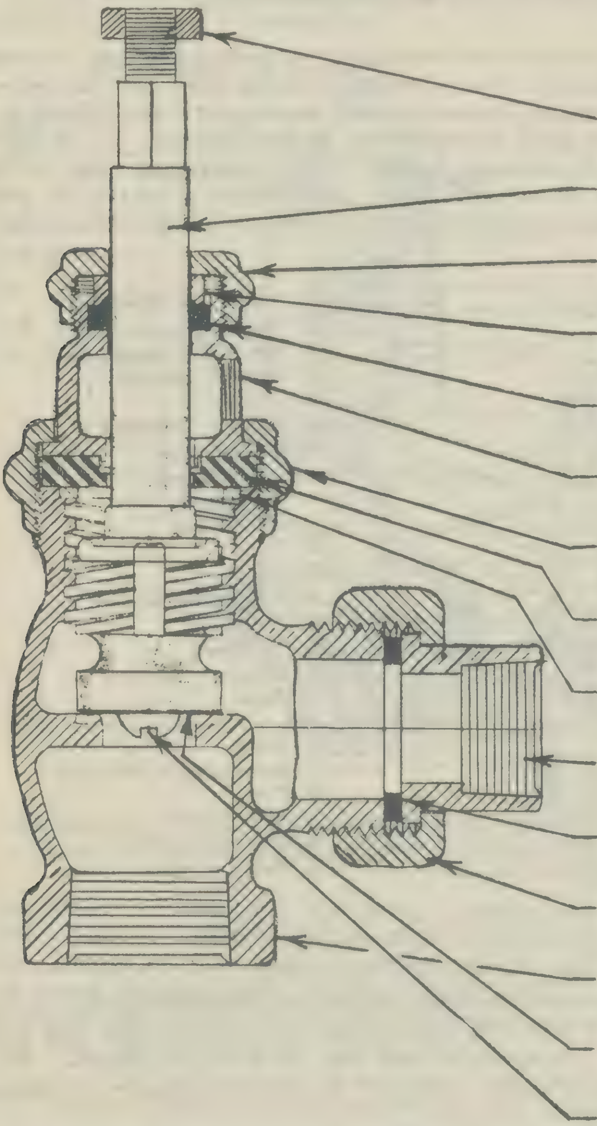
SERVICE HINTS (Maintenance & Repair) - Build up of reduced pressure even with adjusting spring backed off to lowest point indicates leakage by disc part 15. Steam leakage out around head area indicates fracture of diaphragm part 13.

To dismantle, remove head mechanism by loosening adjusting screw part 18, depress head part 8 and turn 60 degrees either way and pick head up through slots. Remove rim bolts part 20, 21 and take off chamber and inspect spring assembly.

Remove bottom plug part 3 and hold square head of main valve part 5. Unscrew diaphragm plate 4 and remove all parts through bottom opening. Slide intermediate bushing part 7 off stem and replace disc 15 with Jenkins #119A or equal material.

Replace all gaskets with long fibre asbestos stock and reassemble. It will be found more permanent to soak disc 15 in hot water before final assembly, to assure tightness. Tighten stem assembly firm but do not crack disc by overload.

If necessary to replace bellows seal part 12, unscrew bushing 9 and tighten solid when reassembling to assure a perfect seal.



PART NO.	DESCRIPTION
3000J	NUT
J382-63c	STEM
441-64	PACKING NUT
574-32	PACKING GLAND
437-06	PACKING
J382-64	DRAIN SLEEVE
441-63	CAP NUT
441-01	RUBBER WASHER
441-36	WASHER
J382-62	UNION END
4590D	FIBRE WASHER
1273-63	UNION NUT
J382-61	BODY
435-014	WASHER
3090A	SCREW

LEAK VALVE

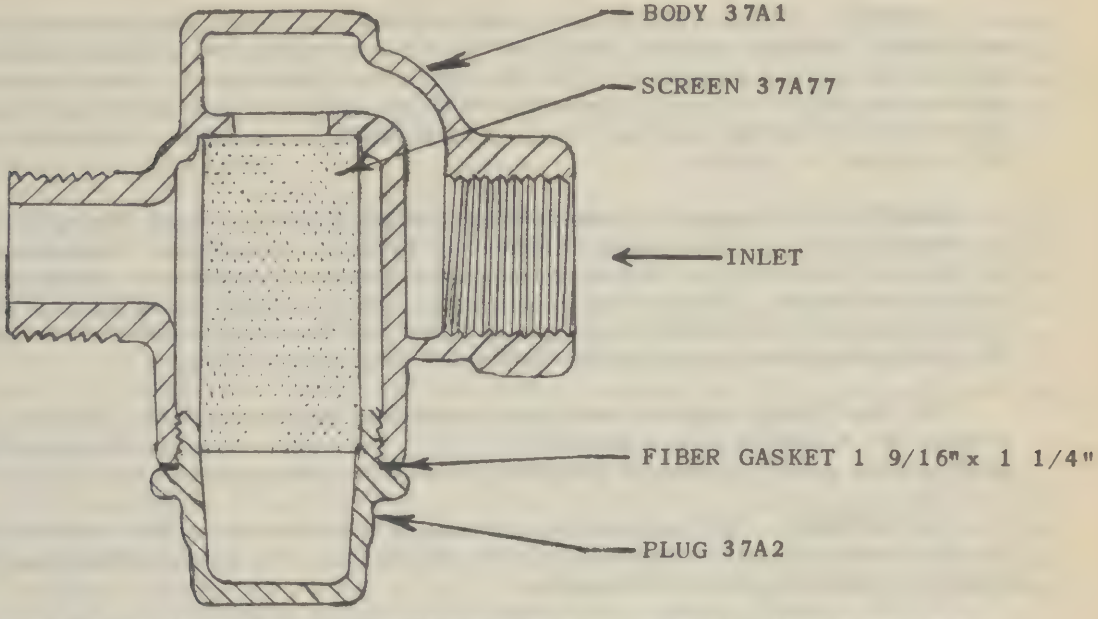
1/2 x 3/8 as used on Water Sterilizers, Instrument and Utensil Sterilizers

PURPOSE OF LEAK VALVE - Leak valves are employed on all sterilizers where water is fed directly into the sterilizer. Its purpose is to make sterilization safe and to guarantee that water cannot contaminate sterile water in case valve does not close tightly.

SERVICE HINTS - No servicing required.

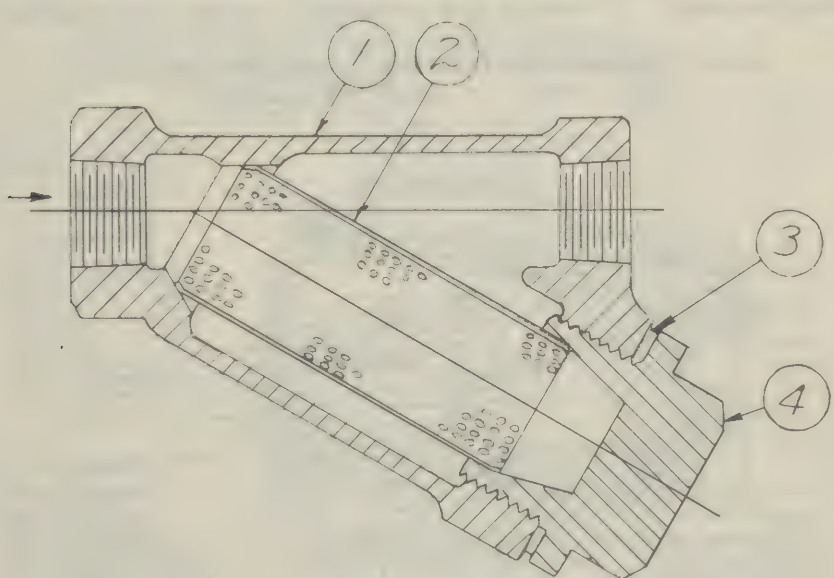
SPECIAL PARTS SECTION

VERTICAL STRAINER TYPE 37 AS USED ON DIRECT STEAM STERILIZERS



PURPOSE OF STRAINER - Steam strainers are used on all direct steam sterilizers in order to protect traps, valves, checks and reducing valves from being clogged up by foreign matter.

SERVICE HINTS (Maintenance and Repair) - Remove plug 37 A 2 occasionally, take out screen 37 A 77 and remove sediment out of same.



PURPOSE OF STEAM STRAINER - Steam strainers are used on all direct steam sterilizers in order to free steam of foreign particles and subsequently to protect traps, check valves, reducing valves etc. from being clogged up by foreign matter.

SERVICE HINTS (Maintenance and Repair) - Remove plug #4 occasionally, take out screen #2 and remove sediment out of same.

PURPOSE - This instrument is used on boiling type (non-pressure) Instrument and Utensil Sterilizers and Pasteurizers for automatic low water cut-off. The instrument is set to break slightly above boiling temperature. When low water level is reached thermostat will break and will not go on unless water has been replenished into sterilizer and hand reset button has been pressed. Only then sterilizer will continue to operate.

OPERATION - The power element, consisting of bulb, capillary tubing and bellows, is charged with a small volume of volatile liquid. Increase of temperature applied to the bulb causes this liquid to vaporize, creating a pressure which operates the switch mechanism. The switch is a single pole, single throw type. The control element causes the switch to cut in and cut out in accordance with the setting of the range adjustment screw and differential adjustment screw.

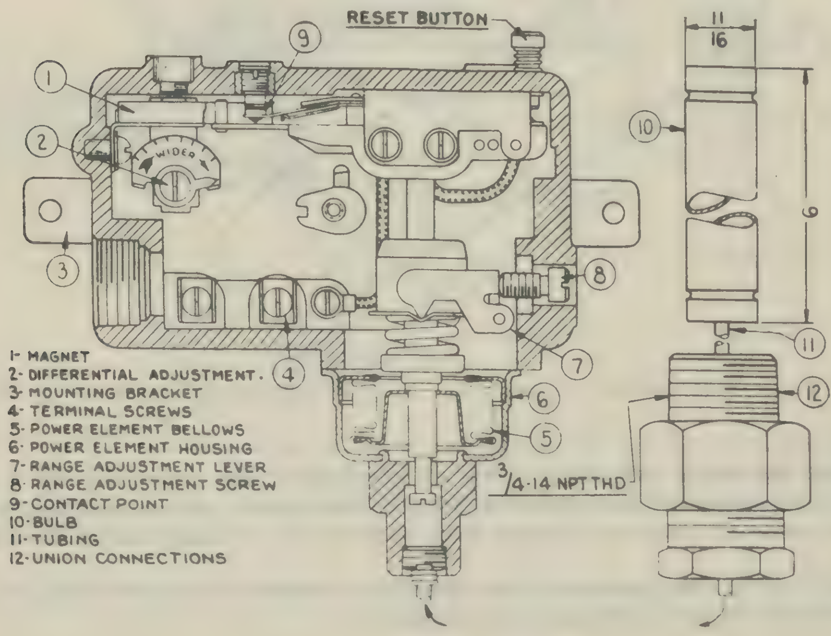
The Hand Reset feature makes the instrument semi-automatic. When contacts are opened due to excessive temperature, they will not close automatically. It is necessary to manually push in the reset button to obtain operation.

ADJUSTMENT - The range or operating adjustment is at the side of the case. The differential adjustment is inside the case. The range adjustment fixes the point at which the circuit "makes".

The differential adjustment affects the "break" point of the circuit. Changing the differential does not alter the "make" point. Turning the differential adjustment "wider" raises the point at which the circuit "breaks". Turning the range adjustment clockwise raises both the "make" and "break" points.

CARE - Keep cover closed. Do not attempt to disconnect or replace any parts. Do not oil any bearings. If repairs are necessary, replace the complete instrument.

#250 TEMPERATURE CONTROL (SEMI-AUTOMATIC)
Unit X-21053 Range 195° to 260°

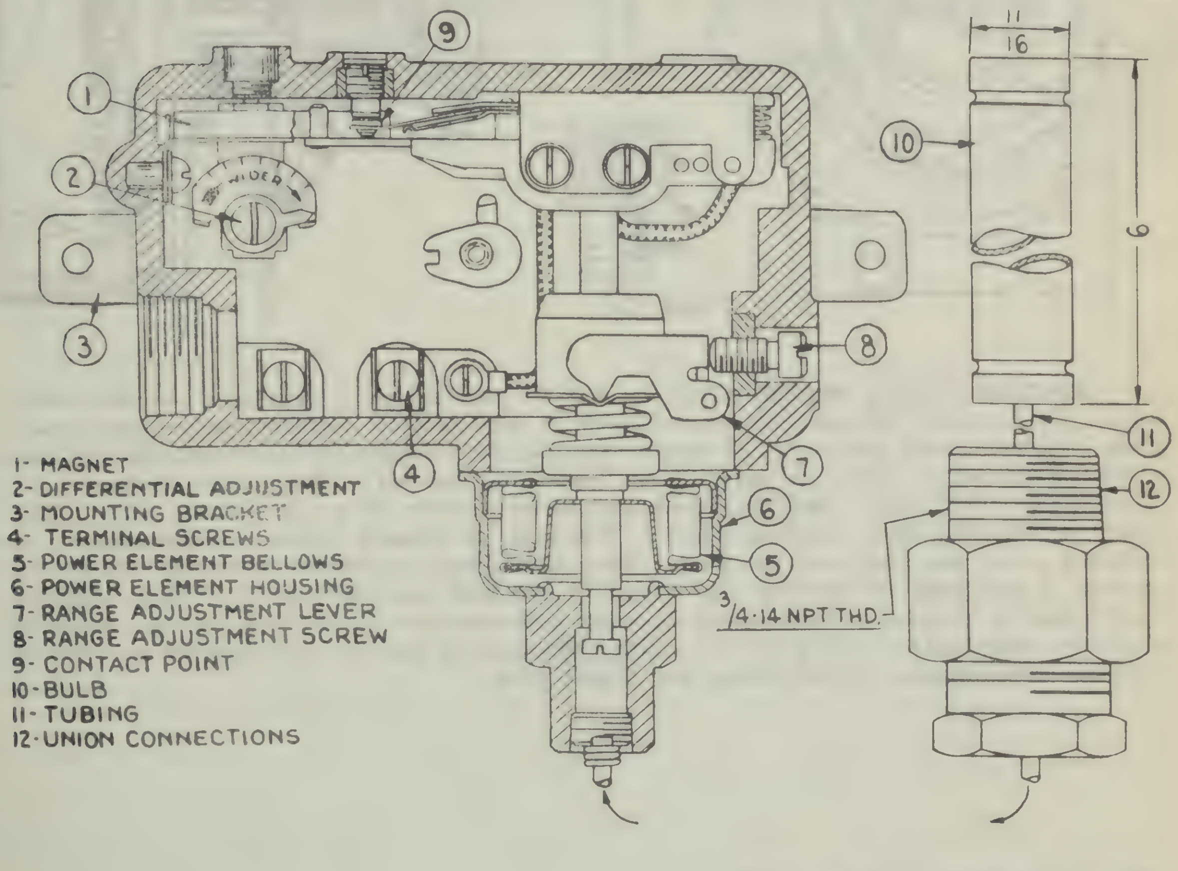


PURPOSE OF TYPE X-21350 (235 to 290°) - This instrument is used as temperature control and a low water cut-off for Pressure, Dressing and Water Sterilizers. Thermostat is set to break at between 256 and 260° F. If temperature exceeds setting, thermostat will break current and automatically maintain set temperature. Also if low water level is reached thermostat will break current and will automatically go on if water is replenished.

PURPOSE OF TYPE X-21076 (195 to 260°) - This instrument is used on boiling type Instrument and Utensil Sterilizers, and Pasteurizers as an automatic excess vapor regulator. Instrument is set slightly above boiling point. If water reaches boiling point and boils violently, thermostat automatically cuts off portion of heating element and will keep water only simmering, thereby keeping boiling temperature but preventing an excess amount of steam escaping from under the cover. If cold water is added into sterilizer and water temperature falls below simmering, thermostat will automatically go on and maintain a mild boiling.

OPERATION - The power element, consisting of bulb, capillary tubing and bellows, is charged with a small volume of volatile liquid. Increase of temperature applied to the bulb causes this liquid to vaporize, creating a pressure which operates the switch mechanism. The switch is a single pole, single throw type, The control element causes the switch to cut in and cut out in accordance with the setting of the range adjustment screw and differential adjustment screw.

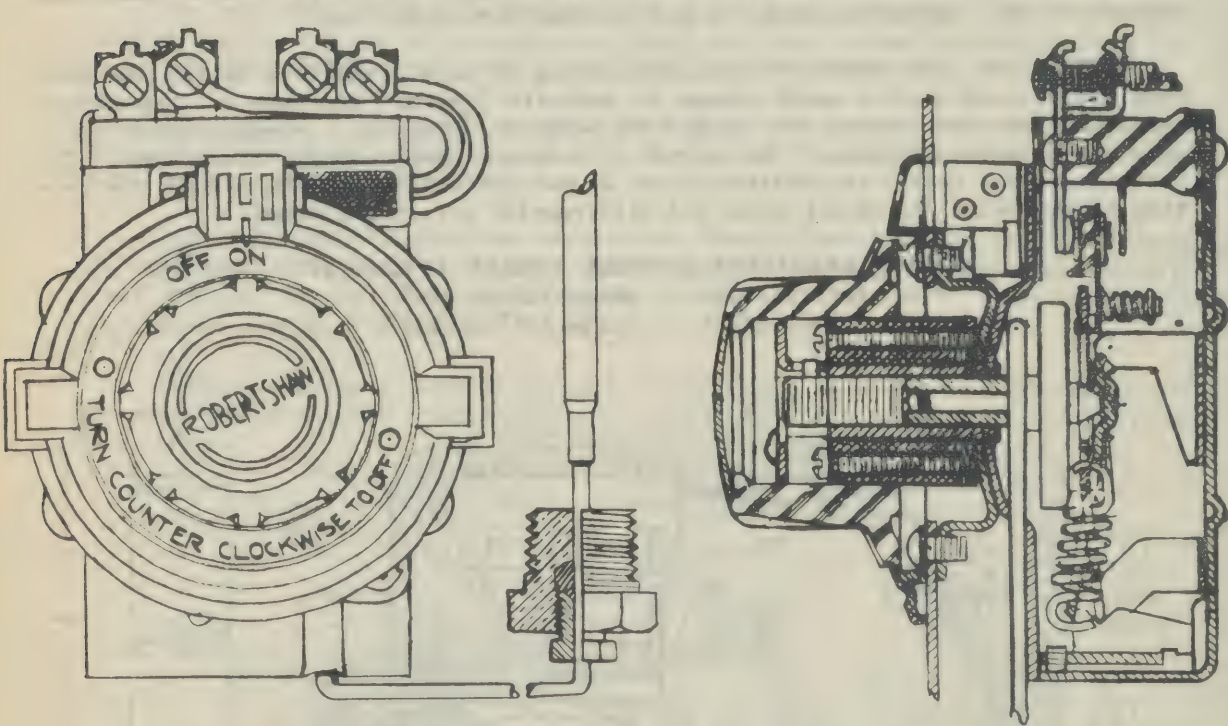
#250 TEMPERATURE CONTROL (FULLY AUTOMATIC)
Unit X-21350 Range 235 to 290°
Unit X-21076 Range 195° to 260°



ADJUSTMENT - The range or operating adjustment is at the side of the case. The differential adjustment is inside the case. The range adjustment fixes the point at which the circuit "makes".

The differential adjustment affects the "break" point of the circuit. Changing the differential does not alter the "make" point. Turning the differential adjustment "wider" raises the point at which the circuit "breaks". Turning the range adjustment clockwise raises both the "make" and "break" points.

CARE - Keep cover closed. Do not attempt to disconnect or replace any parts. Do not oil any bearings. If repairs are necessary, replace the complete instrument.



ELECTRIC CONTROL SWITCH - This switch is used on both pressure and non-pressure sterilizers. On pressure sterilizers it serves as a combination pressure control and low water cut-off. On non-pressure sterilizers it controls the boiling speed of the water and also serves as a low water cut-off. There is a thermal unit comprising a bulb and a bellows connected to each other by a capilliary tube. This unit is filled with a volatile fluid. The bulb is placed inside the sterilizer in contact with the electric heaters. When the specific temperature for which the switch is adjusted is reached, the fluid in the bulb and bellows will have expanded sufficiently to cause the bellows to trip a mechanism which opens up two pairs of contacts thus interrupting the circuit. The switch can be adjusted to operate at various temperatures by adjusting the dialed knob.

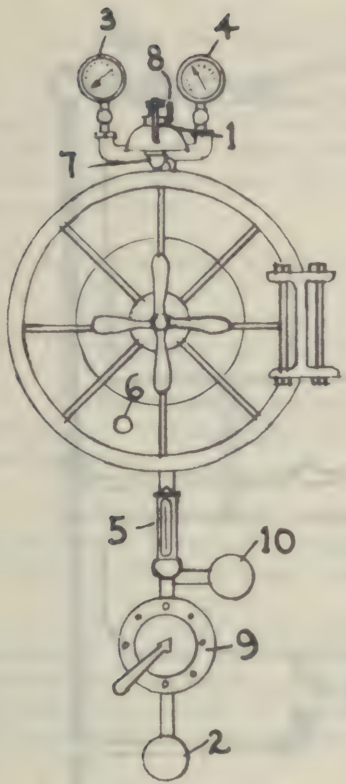
CHAPTER II

STERILIZERS

SECTION 16a

SPECIAL PARTS SECTION
- HOSPITAL SUPPLY STERILIZER -
Operating Instructions

HOSPITAL SUPPLY
AUTOCLAVE DIRECT STEAM



PARTS

1. Lever controlling FOUR-WAY valve.
2. Steam supply valve.
3. Pressure gauge for jacket.
4. Pressure and vacuum gauge for chamber.
5. Thermometer for chamber.
6. Air valve on door.
7. Vacuum cup.
8. Safety valve.
9. Pressure reducing valve.
10. Water supply valve to vapor eliminator.

INSTRUCTIONS FOR OPERATING

1. Close all valves tightly.

2. Place the articles to be sterilized into the sterilizer.

3. Close door. The proper way to close the door is to turn the handle to the left as far as it will go, then to the right and tighten up. The fingers must be fully extended underneath the collar of the sterilizer. The RED mark on the end of the top finger must be hidden underneath the collar; otherwise, the door is not properly closed.

4. Move lever #1 to CLOSE.

5. Open steam supply valve #2 slowly, until open fully.

6. When gauge #3 registers 20 lbs., turn lever #1 to Vacuum and open valve #10 until gauge #4 registers from 5 to 10" of Vacuum (pointer moving to the left). Maintain vacuum for about five minutes. Then close valve #10.

7. Turn lever #1 to STERILE and after thermometer #5 registers 256°, commence sterilizing period. During sterilizing period, partly open air valve #6 permitting a fine stream of steam to pass out.

8. After sterilization is completed, move lever #1 to EXHAUST and open valve #10 until gauge #4 registers ZERO. Then close air valve #6.

9. To dry dressings, turn lever #1 to VACUUM for 15 minutes, during last five minutes of which vacuum breaker #7 should be open.

10. Close valve #2. Turn lever #1 to CLOSE, close valve #10 and when gauge #4 registers ZERO open door and remove sterilized articles.

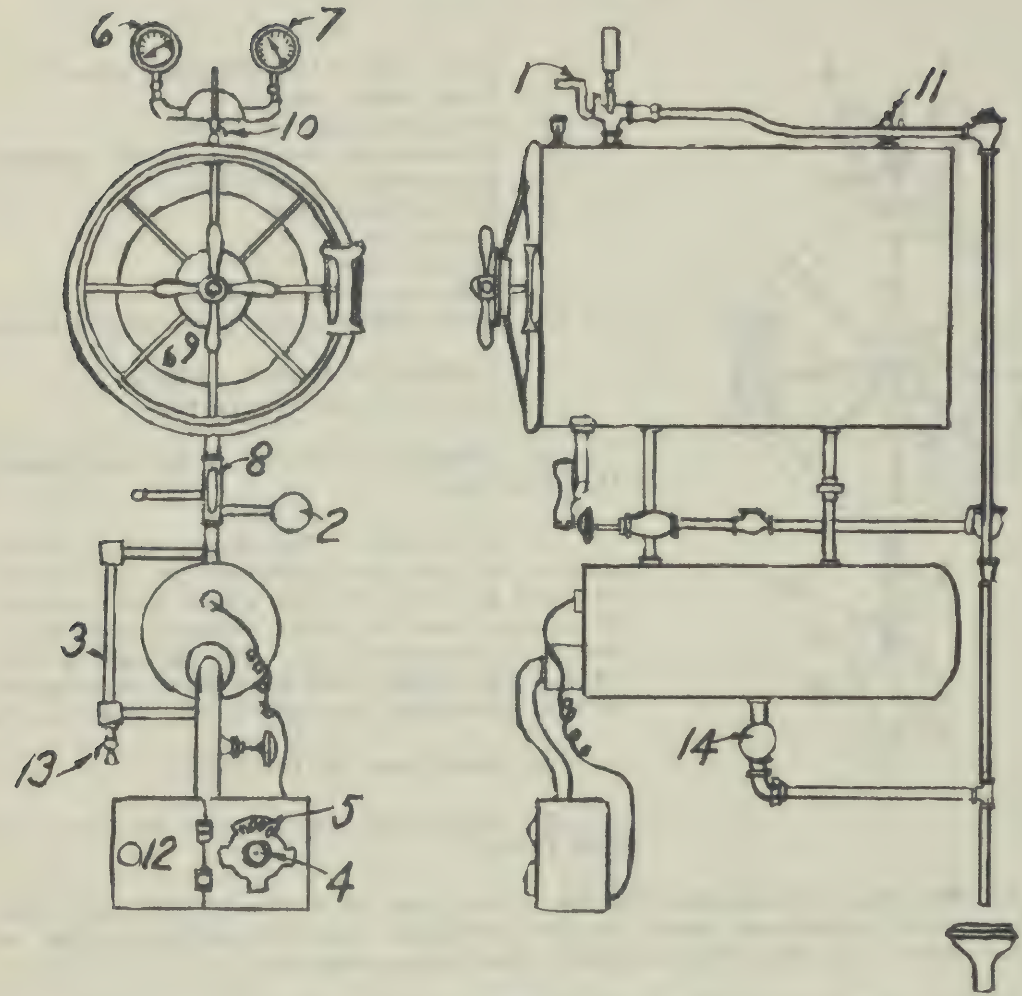
NOTE: Vacuum cup #7 should be filled with clean non-absorbent cotton and should be replaced each day. Cotton should not be packed in too tightly.

CAUTION: Do not pack drums or packages too tightly.

NOTE: Clean out traps and strainers periodically.

SPECIAL PARTS SECTION

AUTOCLAVE ELECTRIC HEAT



PARTS

1. Lever on four way valve.
2. Water supply valve for generator.
3. Water gauge glass.
4. Switch and thermostatic pressure regulator.
5. Pilot light.
6. Pressure gauge to jacket.
7. Pressure and vacuum gauge to chamber.
8. Chamber indicating thermometer.
9. Air valve on door.
10. Vacuum breaker.
11. Safety valve.
12. Fuses.
13. Clean-out cock for water gauge glass.
14. Waste valve.

SPECIAL PARTS SECTION

AUTOCLAVE ELECTRIC HEATED

INSTRUCTIONS FOR OPERATING

1. See that all valves are tightly closed.

2. Place the articles to be sterilized into the sterilizer.

3. Close the door. The proper way to close the door is to turn the handle to the left as far as it will go, then to the right and tighten up. The fingers must be fully extended underneath the collar of the sterilizer. The RED mark on the end of the top finger must be hidden underneath the collar; otherwise the door is not properly closed.

4. Move lever #1 to VACUUM.

5. Open water supply valve #2 and fill generator with water to within 1/4" from top of water gauge glass #3. Then close valve #2. Move lever #1 to CLOSED.

6. Turn knob on switch and thermostatic pressure regulator #4 to desired steam pressure. Pilot light #5 indicates when current is on. Water will heat and generate steam.

7. When gauge #6 registers set pressure, turn lever #1 to vacuum until gauge #7 registers from 5-10" vacuum (pointer moving to left). Maintain vacuum for about 5 minutes. *(Do not draw vacuum when sterilizing solutions.)*

8. Turn lever #1 to STERILE to admit steam into sterilizing chamber. Surgical dressings, gowns, towels, etc., should be sterilized at 259° F. (Thermometer #8) for 30 minutes. Rubber goods at 250° F. for 15 minutes. Solutions at 250° F. for15 minutes. Air valve #9 snould be slightly open during the entire period of sterilization, permitting a fine stream of steam to pass out, to aid circulation.

9. After sterilization is completed, perform the following: When sterilizing dressings, gowns, towels, rubber goods, etc., move lever #1 to EXHAUST, until gauge #7 registers zero, then close air valve #9. When sterilizing solutions, turn lever #1 to CLOSED, and close air valve #9. *Do not exhaust steam from chamber* but permit it to condense slowly to prevent solutions from boiling over.

10. To dry dressings, turn lever #1 to VACCUM for 15 minutes during the last 5 minutes of which vacuum breaker #10 should be open. *When sterilizing solutions, do not draw vacuum.*

11. Turn knob on switch and thermostatic pressure regulator #4 to OFF. Turn lever #1 to CLOSED. When guage #7 registers zero, open door and remove sterilized articles.

12. To clean out water gauge, open clean-out cock #13.

CAUTION - Do not turn on current unless there is water in the generator. Do not permit sterilizer to run dry.

GENERAL INSTRUCTIONS

A) Fill vacuum breaker #10 loosely with fresh cotton each day.

B) Drums and packages must be packed loosely. Packages, glove envelopes etc. should be placed on edge and not stacked.

C) Clean chamber strainer daily.

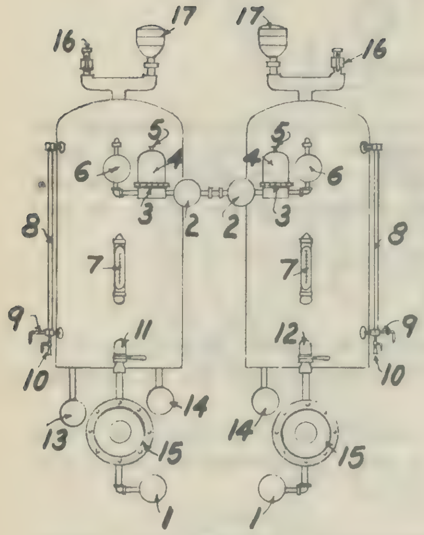
D) Flush chamber drain of all sediment monthly.

E) Flush generator and water gauge glass of sediment monthly.

F) Clean sterilizing chamber periodically.

G) Replace door gasket when it becomes worn.

WATER STERILIZER STEAM HEATED



PARTS

1. Steam supply valve.
2. Water supply valve to filter.
3. Water filter collar.
4. Water filter case.
5. Air valve on water filter.
6. Water supply valve to tank.
7. Thermometer.
8. Water gauge.
9. Pet-cock for sterilizing water in gauge glass.
10. Clean-out cock for water gauge glass.
11. Draw-off faucet for COLD sterile water.
12. Draw-off faucet for HOT sterile water.
13. Water supply valve to cooling coil.
14. Water waste valve.
15. Steam pressure regulator.
16. Safety valve.
17. Air filter and vacuum valve.

INSTRUCTIONS FOR OPERATING WATER STERILIZERS

1. See that all valves are tightly closed.

2. Open valves #2 and #6 and pet-cocks #9 two turns. Fill to within about 1/2" from top of water gauge glasses #8. Then close valves #2 and #6 and pet-cocks #9 tightly. Open filter air valves #5.

3. Open steam supply valves #1 FULL.

4. When thermometers #7 register from 250° F. to 260° F., sterilization begins. Sterilize water for whatever period your technique calls for.

5. When sterilization is completed, close steam supply valves #1 and filter air valves #5.

6. Before permitting the sterilized water from the tank to enter gauge glasses #8, the gauge glasses should be sterilized. This can be done by opening pet-cocks #10. The water will then drain off and the steam from the sterilizer will pass through the gauge glass, thus sterilizing it. Then close pet-cock #10 and open pet-cock #9 two turns, permitting the water from the tank to enter the gauge glass.

7. To cool water in tank marked COLD, open valve #13 and allow water to run through cooling coil until desired temperature is indicated by thermometer #7 on COLD tank.

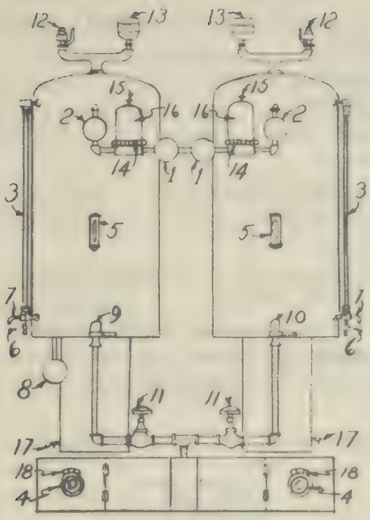
8. To draw-off cold sterilized water, open faucet #11. To draw-off hot sterilized water, open faucet #12.

9. To flush out tanks, open waste valves #14.

NOTE: To replace filter core, loosen collar #3. Then remove filter case #4 and cotton filter. Replace new filter core in case and tighten collar. Refill air filters #17 with cotton after each sterilization.

CAUTION - Do not turn pet-cocks #9 more than two turns. Safety valves are set at 22 lbs. *These must not be touched.*

WATER STERILIZER ELECTRIC HEATED



PARTS

1. Water supply valve to filter.
2. Water supply.
3. Water gauge glass.
4. Thermostatic switch.
5. Thermometer.
6. Clean-out cock for water gauge glass.
7. Pet-cock for sterilizing water in gauge glass.
8. Water supply valve to cooling coil.
9. Draw-off valve for cold sterile water.
10. Draw-off valve for hot sterile water.
11. Clean-out valve.
12. Safety valve.
13. Air filter and vacuum valve.
14. Filter case collar.
15. Air valve on filter
16. Filter case.
17. Clean-out cock on generator.
18. Pilot light.

INSTRUCTIONS FOR OPERATING
(Same instructions apply to each tank)

1. See that all valves are tightly closed.

2. Open valves #1 and #2 and pet-cock #7 two turns. Fill to within about ½" from top of water gauge #3. Then close valves #1 and #2 and pet-cock #7 tightly. Open filter air valve #15.

3. Turn thermostatic switch #4 to "on". Pilot light #18 indicates when current is on.

4. When thermometer #5 registers 250° to 260° F. sterilization begins, sterilize water for whatever period your technique calls for.

5. When sterilization is finished turn thermostatic switch to "off". Close valve #15.

6. Before permitting the sterilized water from the tank to enter the water gauge glass, the water gauge glass should be sterilized. This can be done by opening pet-cock #6; the water will then drain off and steam from the sterilizer will pass through the water gauge glass, thus sterilizing it. Then close pet-cock #6 and open pet-cock #7 two turns, permitting the sterilized water from the tank to enter the water gauge glass.

7. To cool water in tank marked COLD, open valve #8 and allow water to run through cooling coil until desired temperature is indicated by thermometer #5 on COLD tank.

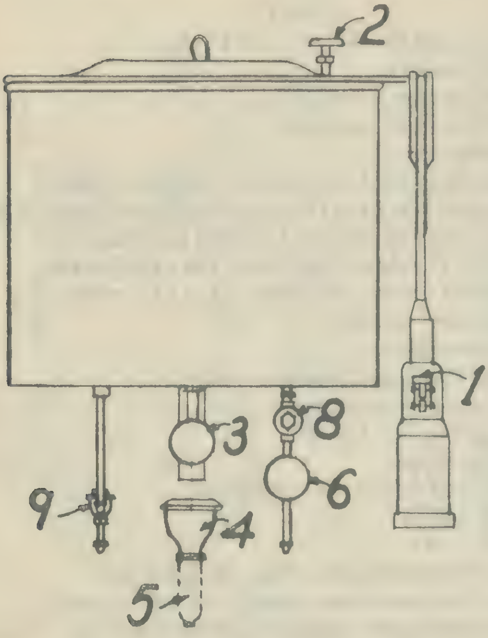
8. To draw off COLD sterilized water, open draw-off valve #9. To draw off HOT sterilized water, open draw-off valve #10.

9. To flush out tanks, open valves #11.

10. To clean out generators, open pet-cocks #17.

SEE THAT THERE IS SUFFICIENT WATER IN TANK BEFORE TURNING ON CURRENT. DO NOT ALLOW STERILIZER TO RUN DRY.

UTENSIL STERILIZER, STEAM HEATED WITH VAPOR REGULATOR



PARTS

1. Pedal for raising and lowering cover and tray.
2. Water supply valve.
3. Waste valve.
4. Air break waste funnel.
5. Waste trap.
6. Steam supply valve.
7. Steam strainer.
8. Vapor regulator.
9. Steam trap.
10. Steam check valve.
11. Stop valve on steam supply line.
12. Stop valve on steam return line.
13. Stop valve on water supply line (not shown).
14. Leak drip on water supply valve.

FRONT VIEW OF APPARATUS

INSTRUCTIONS FOR OPERATING

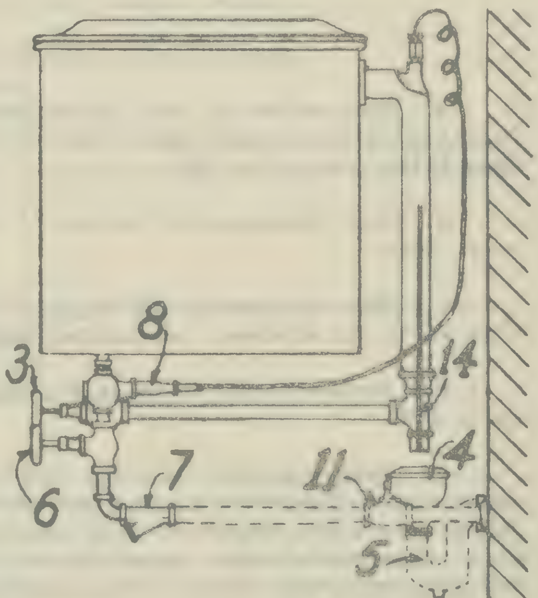
1. To raise cover & tray, press pedal #1 several times. To lower cover & tray, press pedal #1 tipping the toe forward and downward.

2. Open water supply valve #2 and fill sterilizer with water. (Water level can be observed by partially raising cover.) Then close valve #2.

3. Open steam supply valve #6 full.

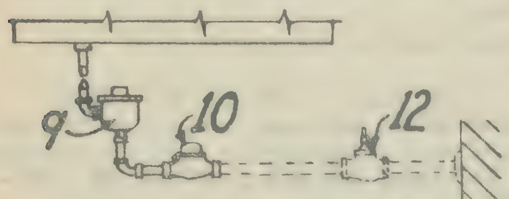
4. Sterilize utensils (timing after water boils) for whatever period your technique calls for. When sterilization is completed, close valve #6.

5. To drain sterilizer, open waste valve #3.

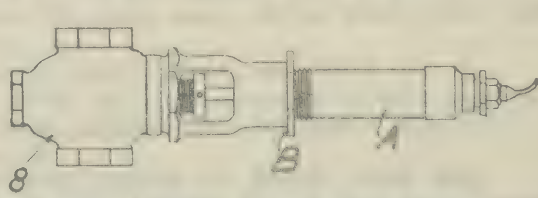


SIDE VIEW OF APPARATUS
Showing Steam Supply & Waste Connections

ADJUSTING VAPOR REGULATOR - After installation, adjust Vapor Regulator #8 to your steam pressure. To do so loosen lock nut B and unscrew tube A a few turns.



DETAIL OF STEAM RETURN



DETAIL OF VAPOR REGULATOR

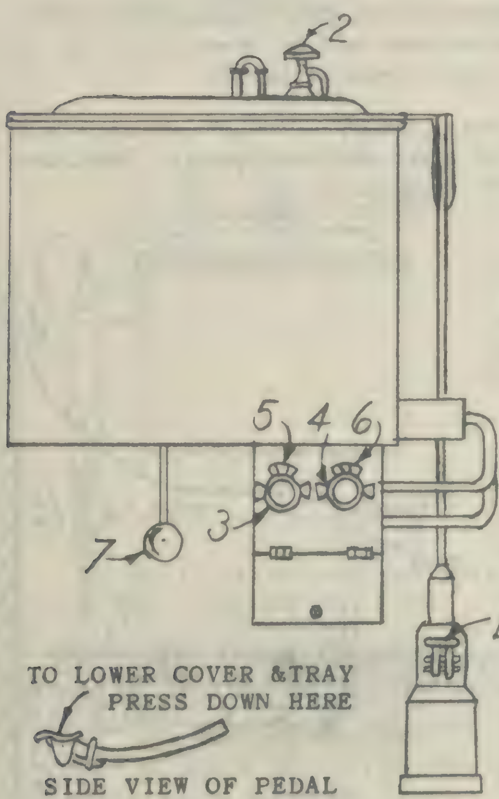
ADJUSTING VAPOR REGULATOR (CON'T)

Boil water in sterilizer as per instructions on previous page. When steam escapes from under cover of sterilizer, slowly screw tube A inward until steam stops escaping. Slight adjustment of tube A in or out may be necessary to attain proper adjustment. Then tighten lock nut B. The purpose of the regular is to reduce intensity of boiling, sufficiently to prevent steam escaping from under cover of sterilizer.

CAUTION - Regulator, when adjusted *must permit sufficient steam through valve to keep water boiling at all times.*

MAINTENANCE - From time to time clean insides of steam trap, steam check and steam strainer.

UTENSIL STERILIZER
ELECTRIC HEATED



PARTS

1. Pedal for raising cover.
2. Water supply valve.
3. Thermostatic switch.
4. Thermostatic switch.
5. Pilot light..
6. Pilot light.
7. Waste valve.

INSTRUCTIONS FOR OPERATING

1. To raise cover, press pedal #1 several times. To lower cover, press pedal #1 down and hold in catch attached to stand.

2. Fill sterilizer with water by opening Water Supply Valve #2. Utensils should be covered with water.

3. Turn thermostatic switches #3 and #4 to ON. Pilot lights #5 and #6 will indicate when current is on.

4. Sterilize utensils for whatever period your technique calls for.

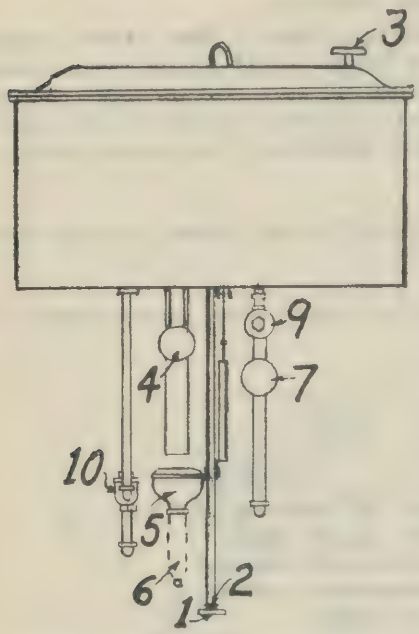
5. When sterilization is completed, turn thermostatic switches #3 and #4 to OFF.

6. To drain sterilizer, open waste valve #7.

NOTE --When water is boiling, thermostat #3 will shut off current of one heater, second heater will keep water boiling. If water boils off to lowest permissable level, thermostat #4 will shut off second heater. To restore current, refill sterilizer with water.

CAUTION - SEE THAT THERE IS SUFFICIENT WATER IN STERILIZER BEFORE TURNING ON CURRENT. DO NOT PERMIT WATER TO BOIL OFF TO A POINT BELOW TOP OF HEATER.

INSTRUMENT STERILIZER, STEAM HEATED WITH VAPOR REGULATOR



FRONT VIEW OF APPARATUS

PARTS

1. Pedal for raising cover & tray.
2. Button to lower cover & tray.
3. Water supply valve.
4. Water waste valve.
5. Air break waste funnel.
6. Waste trap.
7. Steam supply valve.
8. Steam strainer.
9. Vapor regulator.
10. Steam trap.
11. Steam check valve.
12. Stop valve on steam supply line.
13. Stop valve on steam return line.
14. Stop valve on water supply line.(not shown).

INSTRUCTIONS FOR OPERATING

1. To raise cover & tray, press pedal #1. To lower cover & tray, press button #2.

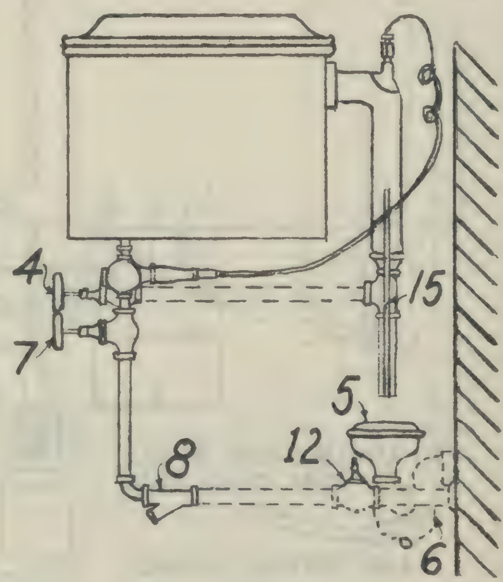
2. Open water supply valve #3 and admit sufficient water to cover the instruments. Then close valve #3.

3. Open steam supply valve #7 full.

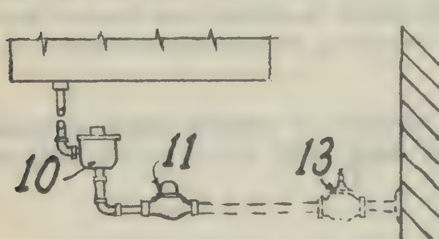
4. Sterilize instruments (timing after water boils) for whatever period your technique calls for. When sterilization is completed, close valve #7.

5. To drain sterilizer, open waste valve #4.

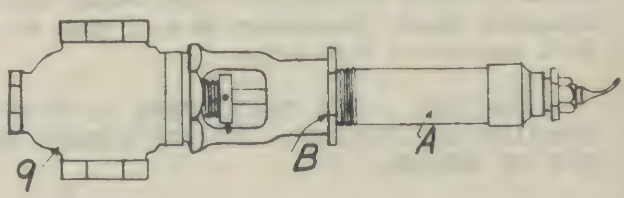
ADJUSTING VAPOR REGULATOR - After installation, adjust vapor regulator #9 to your steam pressure. To do so loosen lock nut B and unscrew tube A a few turns. Boil water in sterilizer as per above instructions. When steam escapes from under cover of sterilizer, slowly screw tube A inward until steam stops escaping. Slight adjustment of tube A in or out may be necessary to attain proper adjustment. Then tighten lock nut B. The purpose of the regulator is to reduce the intensity of boiling, sufficiently to prevent steam escaping from under cover of sterilizer.



SIDE VIEW OF APPARATUS
Showing Steam Supply & Waste Connections



DETAIL OF STEAM RETURN



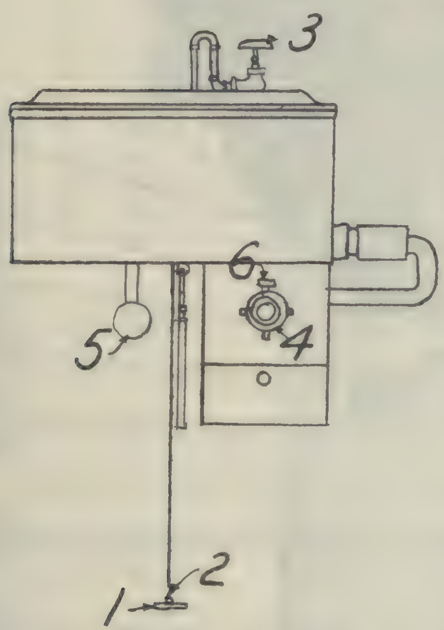
DETAIL OF VAPOR REGULATOR

CAUTION - Regulator, when adjusted *must permit sufficient steam through valve to keep water boiling at all times.*

MAINTENANCE - From time to time clean insides of steam trap, steam check and steam strainer.

NOTE - A little carbonate of soda may be added to the water to prevent the instruments from being discolored.

INSTRUMENT STERILIZER
ELECTRIC HEATED, WITH AUTOMATIC REGULATOR



PARTS

1. Pedal for raising cover and tray.
2. Pedal for lowering cover and tray.
3. Water supply valve.
4. Thermostat (automatic control).
5. Waste valve.
6. Pilot light.

INSTRUCTIONS FOR OPERATING

1. To raise cover and tray, press down on pedal #1.

2. To lower cover and tray, press down on pedal #2.

3. Open water supply valve #3 and admit sufficient water into the sterilizer to cover the instruments. Then close valve #3.

4. Turn on electric current. To do so turn automatic control #4 to the right as far as it will go, to ON.

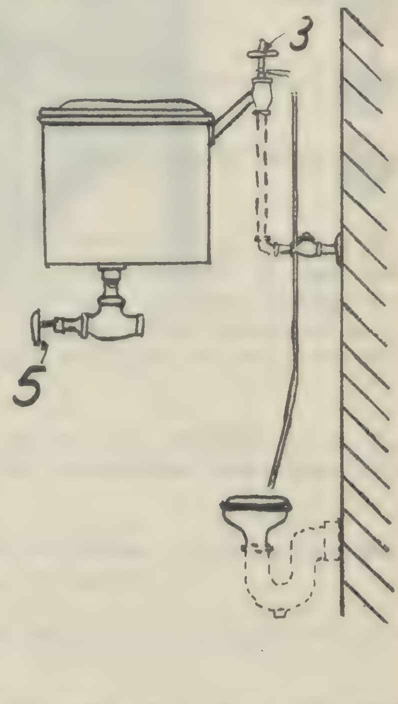
5. Boil instruments for whatever period of time your technique calls for.

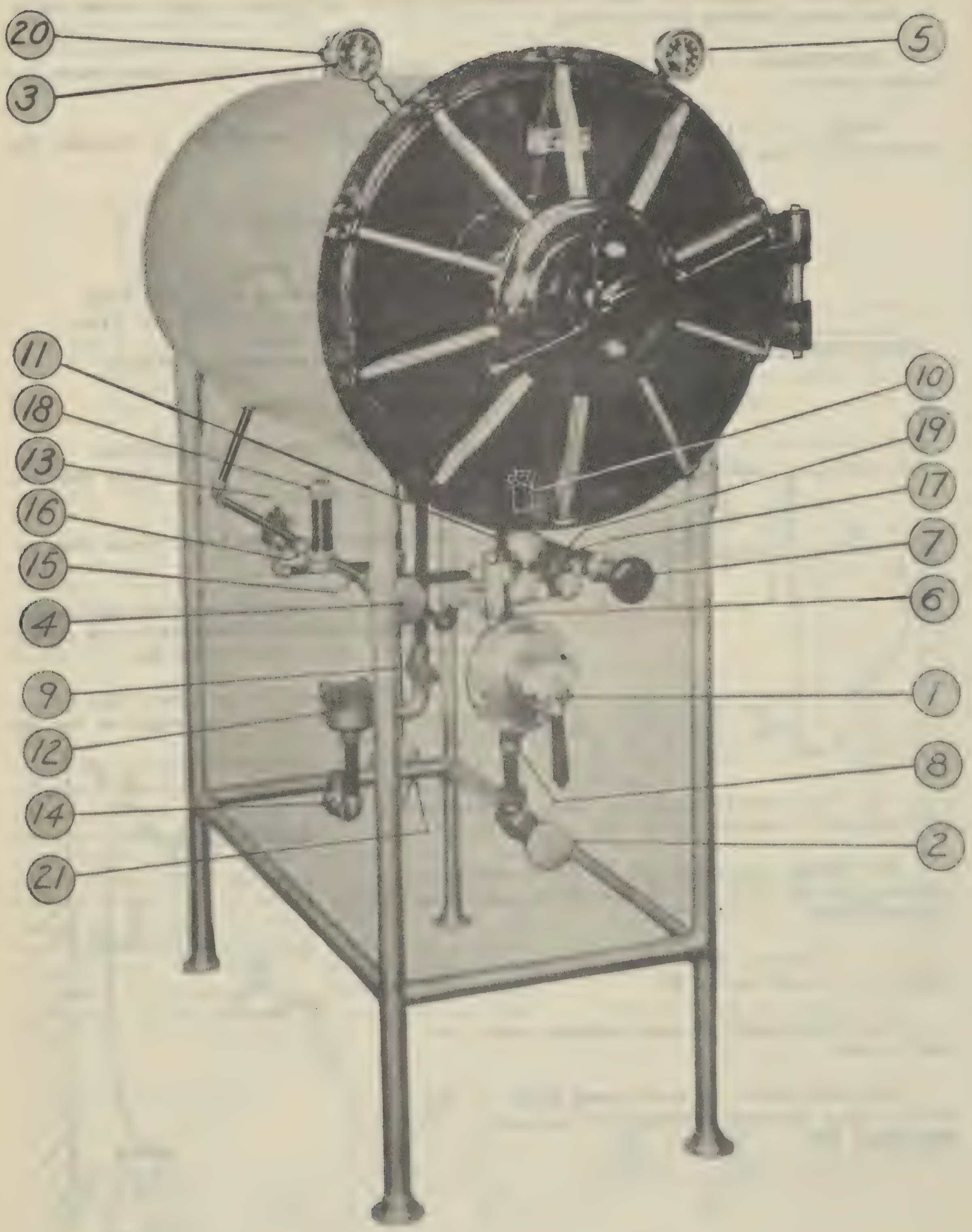
6. After sterilization is completed turn automatic control #4 to the left until it reaches OFF.

7. To drain water from the sterilizer, open water waste valve #5.

8. Pilot light #6 will indicate when current is on.

See that there is sufficient water in the sterilizer before turning on current. DO NOT BOIL DRY.

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SPECIAL PARTS SECTION

DRESSING STERILIZER STEAM HEATED

PARTS

1. Pressure reducing valve.
2. Main steam supply valve.
3. Jacket pressure gauge.
4. Steam supply valve to chamber.
5. Chamber pressure gauge.
6. Chamber thermometer.
7. Exhaust and ejector valve.
8. Steam strainer on main steam supply line.
9. Steam strainer on steam return line.
10. Chamber strainer.
11. Jacket strainer.
12. Steam trap on steam return line.
13. Steam trap on chamber condensation line.
14. Check valve on steam return line.
15. Check valve on chamber condensation line.
16. Air cock on air filter.
17. Check valve on exhaust line.
18. Air filter.
19. Steam ejector.
20. Safety valve.
21. Waste funnel.

OPERATING INSTRUCTIONS

1. Close all valves and cocks tightly.

2. Place the articles to be sterilized into the sterilizer.

3. Close door. The proper way to close the door is to turn the handle to the left as far as it will go, then press the door firmly against gasket and tighten up by turning handle to the right.

IMPORTANT:- Make sure that every finger is fully extended under its corresponding U-bolt.

4. Set pressure reducing valve #1 to desired steam pressure.

5. Open Main Steam Supply Valve #2 fully.

6. When Jacket Gauge #3 registers set pressure, open Steam Supply Valve #4 to admit steam into sterilizing chamber.

7. After sterilization is completed, perform the following: When sterilizing dressings, gowns, towels, rubber goods, etc., close steam supply valve #4 and open exhaust valve #7 for approximately 15 minutes, thus creating a vacuum. During the last 5 minutes of this period, air cock #16 should be opened. This procedure will exhaust steam from chamber and dry sterilized articles by means of a continuous flow of filtered air through filter #18.

When sterilizing solutions, close valve #4, *but do not open Exhaust Valve #7.* This procedure will permit steam to condense slowly, thus preventing solutions from boiling over.

8. Close all valves tightly. (If additional sterilizations are to follow, Main Steam Supply Valve #2 may be left open to maintain heat in jacket.)

9. When gauge #5 registers Zero, open door and remove sterilized articles.

[illegible]

CHAPTER II

STERILIZERS

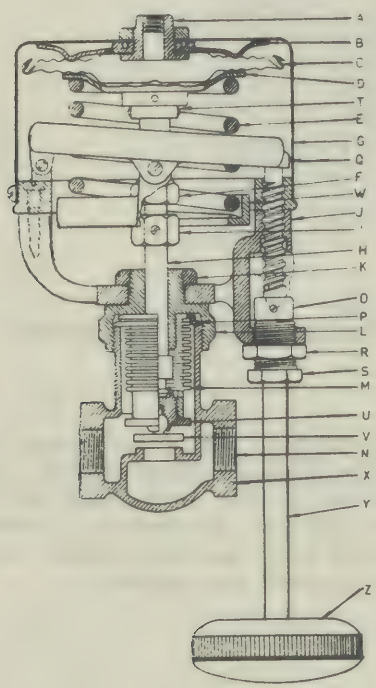
SECTION 17

SPECIAL PARTS SECTION
- SCANLAN MORRIS STERILIZER -

TO RESET THE DOOR ON THE SCANLAN-MORRIS AUTOCLAVE

Slightly loosen the top and bottom bolts on the face of the hinge, leaving the center one tight, and with the door lightly held in the door collar. If the door has sagged, causing it to drag on the guide lug in the left lower section of the collar, insert a board or bar under the door and pry up slightly, locking the top and bottom bolts in the new position. Swing the door open and closed to see that it just clears the guide lug and lines up perfectly with the gasket.

SCANLAN MORRIS AUTOMATIC SELECTIVE CONTROL VALVE FOR STEAM HEATED DRESSING STERILIZERS - This Automatic Selective Pressure Control Valve is designed to control and maintain a predetermined steam pressure within the dressing sterilizer. A higher pressure for the sterilization of dressings and a lower pressure for the sterilization of rubber goods and other materials may be secured. The maximum differential between the high and low limit is approximately seven pounds. Any desired pressure within these limits may be attained. Due to a wide variation of steam supply pressures at various installations, the Control Valve must be set for permanent operation after the sterilizers are installed.



The Control Valve is designed for a maximum pressure of seventy (70) pounds on the steam supply line. A higher pressure will soon destroy the valve seat and bellows. For this reason, should the steam supply line exceed sixty-five (65) pounds pressure at the sterilizers, a steam reducing valve should be installed on the riser.

The Steam Control Valve consists of a quick-opening packless valve operated by a large diaphragm which expands or contracts in proportion to the pressure in the sterilizers. The expansion of the diaphragm is governed by a heavy compression spring. As the pressure in the sterilizer approaches the desired level, the diaphragm expands and closes the valve, admitting less steam. As the pressure in the sterilizer lowers, the diaphragm contracts, opening the steam valve and admitting more steam. When properly adjusted, the Control Valve admits the correct amount of steam to maintain a constant steam pressure in the sterilizer.

LIST OF PARTS

A- 1/8" Pipe Connection
B- Cover Plate
C- Diaphragm
D- Diaphragm Seat
E- Spring
F- Valve Stem Lock Nut
G- Cover
H- Valve Sterm
I- Stem Adjusting Collar
J- Yoke
K- Yoke Lock Nut
L- Bonnet
M- Bellows
N- Steam Inlet
O- Stop Collar
P- Bellows Seat
Q- Ring-Shaped Lever
R- Adjustable Sleeve Lock Nut
S- Adjustable Sleeve
T- Universal Joint
U- Valve Disc Holder
V- Valve Disc
W- Spring Cup
X- Valve Body
Y- Adjusting Screw
Z- Adjusting Handle

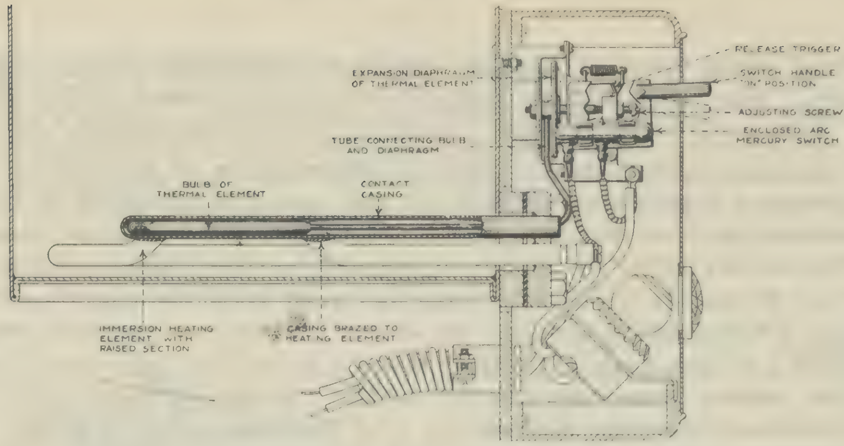
TO SET THE STEAM CONTROL VALVE ON DRESSING STERILIZERS - Open STEAM SUPPLY VALVE and allow the sterilizer to become fully heated. To set the valve, turn the CONTROL HANDLE (Z) to the right (clockwise) until STOP COLLAR (O) hits YOKE RING (J) as shown by dotted lines. This is the position of the higher of the two desired pressures. Then loosen LOCKNUT (F) and turn the ADJUSTING NUT (I) to the left (anti-clockwise O to decrease the pressure, or to the right (clockwise) to increase the pressure. When the proper adjustment for the HIGH pressure is obtained (usually 18 or 20 pounds per square inch) as read from the right hand (jacket) gauge, tighten LOCKNUT (F) securely. To adjust for the low pressure point, first loosen LOCKNUT (R) and turn ADJUSTING SCREW (S) to the left until the end is flush with the guide. Then turn CONTROL HANDLE (Z) slowly to the left until the desired low pressure point is reached, as read from the pressure gauge. Now turn ADJUSTING SCREW (S) until it contacts STOP COLLAR (O) on SCREW (Y) and tighten LOCKNUT (R) securely.

If there is a continual escape of steam around the valve stem, and the BONNET (L) is tight, it may be taken as an indication that the BELLOWS (M) is leaking steam. When this occurs, it is necessary to install a new bellows in the valve.

To take the valve apart, remove the PIPE CONNECTIONS (A), at the top of the valve and unscrew the BONNET (L) from the VALVE BODY (N).

Replacement parts may be secured from the Scanlan-Morris Company at a nominal charge. Order only by part, name and letter, as indicated on the drawing.

CAUTION: Failure of the steam control valve to maintain a constant steam pressure in the sterilizer is usually caused by fluctuations of the pressure in the steam supply line. A pressure gauge should be installed on the STEAM SUPPLY line where it enters the sterilizing room, to permit a check on the available pressure. Undersized steam supply lines frequently cause trouble, and ADEQUATE supply of DRY steam is necessary for the satisfactory operation of the sterilizers.



THE LOW WATER PROTECTIVE CUTOUT TYPES G, H, H-A - PRINCIPLE OF OPERATION - Type G, H, and H-A low water protective cutouts consist of mercury tube switches which may be actuated manually, or automatically. A friction mounting permits the tubes to be tilted manually, by the switch handles. A trip mechanism actuated by the expansion of a diaphragm causes the tubes to be tilted to the OFF position whenever the temperature of the heating unit rises above a safe level. The trip mechanism is manually reset by raising either switch handle. When the temperature of the heating units rises above a safe level, the bulb of the thermal element in the contact casing, which is brazed to the heating units is heated sufficiently to cause the liquid in the thermal element to expand and create sufficient pressure in the diaphragm to trip the switch to the OFF position.

The cutout switches are made in three types as follows:

Type G with one mercury tube,
Type H with two mercuty tubes,
Type H-A with three mercury tubes.

Type switch is normally used in the control circuit of sterilizers equipped with automatic heat control. Type H and H-A have two operating levers and are normally used on manual heat control equipment. The number of watts controlled by each lever is indicated on the direction plate. When both switch levers are up, full heat is on.

ACTION OF CUTOUT BY LOW WATER - Low water includes all conditions in which there is insufficient water in the sterilizer to completely cover the heating elements, which are designed to operate completely covered with water. If the elements are not completely immersed, the heat will not be conducted away as fast as it is generated in the heating unit, and the temperature of the elements will soon rise above the point necessary to trip the switch. When low water has caused the switch to open, it cannot be reset until the sterilizer has been refilled with water, or until the heating elements cool down to a safe temperature. If low water has caused the switch to open, it should not be reset without adding water. The switch is automatically reset the next time the switch is turned on, providing the heating elements have cooled sufficiently.

ACTION OF THE CUTOUT BY LIME DEPOSIT - Accumulation of lime on the heating elements prevents the heat from being dissipated into the water as fast as it is generated. As lime accumulates, the temperature of the heating elements soon rises above a safe level and causes the thermal element of the cutout toexpand, thereby tripping the switch on the heating circuit. When this condition occurs, the heating elements should be cleaned. Under no conditions should the switch be blocked or wedged so that it cannot operate freely.

When a sterilizer has been operating satisfactorily for several weeks or months and then the cutout switch starts to trip out during the sterilizing period, it may be taken as an indication that the heating unit needs cleaning. Periodic inspection and cleaning (if necessary) of the heating unit is recommended. Lime deposit 1/16" thick is sufficient to cause trouble.

METHODS OF TESTING CUTOUT SWITCH - The operation of the cutout switch should be checked occasionally to assure positive working conditions. The following procedure should be followed in testing the cutout:

1. Fill sterilizer with water to completely cover heating units.

2. Remove cover of heater head (and end plates if necessary) so that action of diaphragm be readily observed.

3. Turn on full heat. Allow water to boil in non-pressure sterilizers: raise to 15# pressure in autoclaves; and to 250°F. in water sterilizers.

4. Observe expansion of diaphragm during this heating period. If switch is operating correctly and the heating units are free of lime, there should not be over 1/16" expansion of the diaphragm during the normal heating period.

5. Shut off the heat.

6. Drain sterilizer of all water immediately after shutting off heat.

7. While sterilizer is still hot, turn on full heat for exactly *TWENTY SECONDS* and then shut off current by opening wall switch or pulling power supply plug, leaving the cutout switch on the *ON* position.

8. If cutout is properly adjusted and in working order, the switch should automatically open within the next sixty seconds after the current is turned off.

9. Cover elements with water immediately after test.

Watch the diaphragm during this test to see the amount of expansion. If the diaphragm fails to expand, the diaphragm element is inoperative and a new one should be installed. If there is not sufficient expansion to trip the switch, the adjusting screw is not screwed in far enough to allow the release trigger to move out from under the trip plate.

The maximum movement of the diaphragm is from 1/8" to 3/16" at the end of the trip trigger. When the sterilizer is cold, the end of the release trigger should be under the end of the horizontal trip plate about 1/16". If the cutout fails to operate satisfactorily, immediately cover the heating unit with water, re-adjust the contact adjusting screw, and repeat the test, replacing the diaphragm power element if necessary. Turning the adjusting screw in (to the right) speeds up the tripping action; turning out, delays it. Tighten Locknut when through.

To install a new diaphragm power element, simply remove the three screws holding the switch to the diaphragm mounting plate and drop the switch forward. No wires need be removed. Then remove the diaphragm from the heater head and pull the bulb out of the contact casing by pulling straight forward. In installing a new diaphragm, be sure that the bulb lies directly over the point where the casing is brazed to the heating unit. Do not kink the tube sharply or flatten the tube at any point when installing.

OPERATION AND MAINTENANCE OF TYPE #264PA PRESSURE SWITCH

On the A420E autoclave equipped with dual automatic pressure control, two #264PA pressure control switches are used, one set to maintain the pressure in the sterilizer at about 20 lbs., the other at about 15 lbs. On the A410E electrically heated water sterilizers one pressure switch only is used on each reservoir, set to maintain the water in the tank at 250^{o}-255^{o}F.

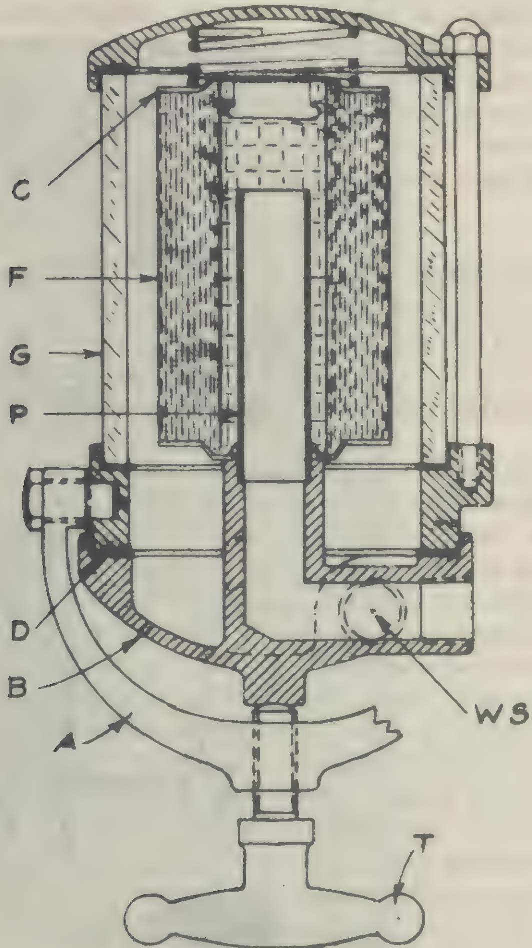
The Type #264PA switch has a removable two-section cover, replacable silver alloy contacts and a fixed operating differential of 1-1/2 to 2 lbs. The pressure at which the switch opens is easily adjusted by turning the knurled knob on top of the switch. Turning the knob clock-wise (when looking down on the top of the switch) increases the tension on the control spring and raises the pressure at which the contacts open. Turning the knob to the left (or counter clock-wise) lowers the opening pressure. Half a turn of this knob changes the operation pressure about 4 lbs.

Each switch is operated through an expansion bellows on the bottom of the case which in turn is connected to the sterilizer by a small tube through which pressure from the sterilizer expands the bellows and opens the switch contacts. When sterilizers are first put in operation, the adjustment of the switch may have to be changed within a month or so due to the static pressure formed by the weight of the water in the connecting tube. For each foot of tubing (in height) nearly a half pound pressure can be exerted on the switch. Therefore, when the tube is full of condensate, the adjustment of the switch should be made to compensate for this difference.

On autoclaves on *HIGH*, the jacket gauge should show a pressure of about 21 lbs. when the switch opens (and white pilot light goes out) and a pressure of about 19 lbs. when the switch closes (and the white light comes on again). On *LOW* the other pressure switch should open at about 16 lbs. and close at 14 to 14-1/2 lbs. When the control is set on *HIGH*, the pressure change switch marked *HIGH/LOW* merely short circuits the 15 lbs. pressure switch. (See circuit diagram in Section 11 under Scanlon-Morris.)

The operation of the switch may be observed by merely removing the front section of the cover after loosening the screw in the center at the edge of the cover.

CARE OF FULLFLO VISIBLE WATER FILTERS - All water used in the high pressure water sterilizers passes through the visible flow water filters before entering the tanks. The honey-comb filter unit, made of long fiber cotton, consists of a multiplicity of minute passages for the collection of sediment and impurities. The filter may be backflushed by steam by opening the Filter Valve for a few minutes, after the sterilizer has been brought up to pressure. This will dislodge any loose sediment on the filter unit and wash it down to the bleeder strainer. The strainer should be cleaned when the filter fails to drain after filling the tanks as described in the operating directions.



The filter unit should be replaced with a new one, when the collection of suspended matter has retarded the flow of water through the filter. To remove the filtering unit unscrew the T-handle screw (T) at the bottom of the filter sufficiently to permit swinging the yoke (A) 90 degrees.

Swinging the yoke 90 degrees raises the body off the gasket seat so that the casing assembly may be slipped up clear of the filter unit (F). Pull up the soiled filtering unit and replace it with a new one making sure that the spring seal is replaced the same way it was removed. Make sure the gasket (D) is in good condition and clean. Replace the filter case after having cleaned out the inside of the glass cylinder and tighten T-handle screw (T) securely.

After filling the tanks, and closing the WATER SUPPLY valve to the filter, (leaving the valve between the filter and the tank open) the water should disappear entirely from the filter glass within the next half minute. If it does not disappear, the bleeder line from the filter is usually obstructed at the filter screen attached to the compression elbow to which the bleeder tube is attached. To clean screen, disconnect the bleeder tube from the elbow, and unscrew the elbow from the fitting in the line between the water supply valve and the filter. Clean the screen attached to the top of the elbow and replace. Also check the opening in the inside

of the bottom of the filter housing when the glass is removed to be sure there is no obstruction over the opening.

Replace the rubber gasket (D) - (see illustration) - whenever they become hardened, torn, or they leak water when filling the sterilizer.

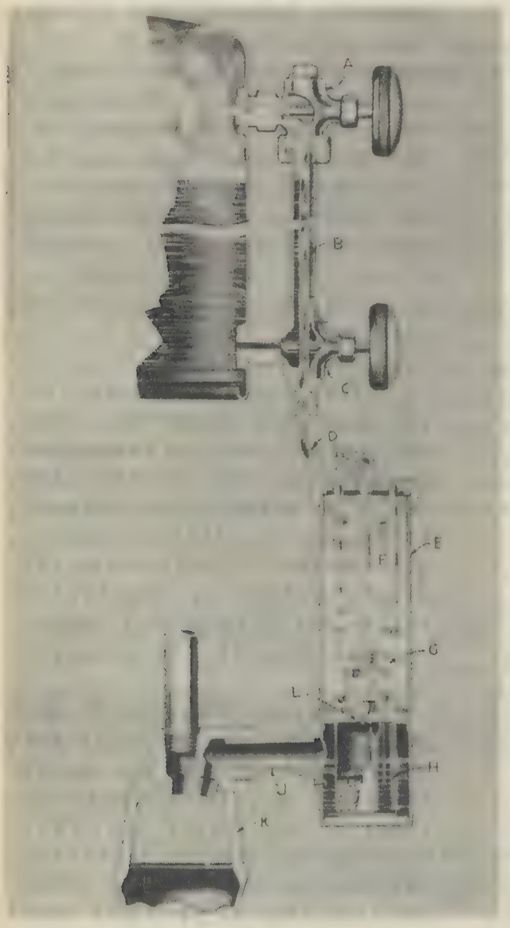


FIGURE 1

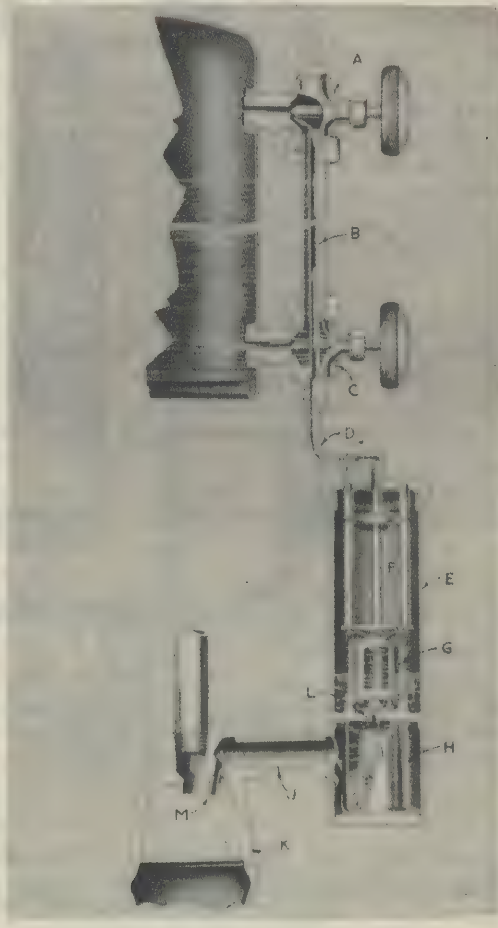


FIGURE 2

MAGATH STERIL-GUARD DEVICE FOR WATER STERILIZERS - Figure 1 shows the action of the Magath Steril-Guard during the sterilizing period. The air in the reservoir and the steam being generated pass out through the upper gauge fitting (A), down through the metal tube (B), through the condensing chamber (F), through the port (L), through the lower compartment (H), and out to the waste line through the overflow (J). As the steam condenses, it automatically fills the lower compartment (H) with pure distilled water, the excess draining out through the overflow (J). As the water in the reservoir reaches the sterilizing temperature, the thermal element (G) expands and closes the port (L). During the sterilizing period, the periodic operation of the trap element maintains a flow of steam through the tube in the

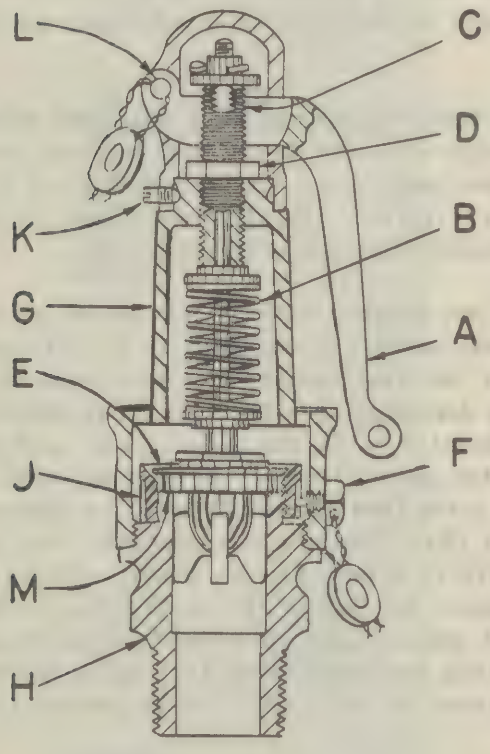
Figure 2 shows the operation of the Magath Steril-Guard after completion of the sterilizing period when air is admitted to the reservoir; also whenever water is drawn from the reservoir. After sterilization, the thermal element (G) contracts and opens the port (L). Air is drawn in through the open air break waste fitting (K) at (M), through the overflow pipe (J), down through the outer section of the lower compartment, up through the distilled water and porcelain beads in the washing chamber (H), through the port (L) and the upper chember (F), and up through the tube (B) into the reservoir at the upper gauge fitting (A). Dust and bacteria are removed as the air passes through the porcelain beads and distilled water of the washing chamber, positively preventing contamination of the sterile reservoir by unsterile air. Each time that water is sterilized, the washing chamber of the Magath Steril-Guard is automatically filled with a new supply of pure distilled water and the old is discharged into the waste.

OPERATION AND CARE OF MAGATH STERIL-GUARD DEVICE ON HIGH PRESSURE WATER STERILIZERS - The water sterilizers are equipped with the Magath Steril-Guard (patented) device for automatically sterilizing the gauge glass and sterilizing and filtering the air entering the tanks after sterilization. A full description of the operation of this device is given on the attached catalog sheet B-39.

The gauge glass should start to heat, and bubbles form on the inside of the glass as steam begins to form in the tank; and as long as pressure is in the tank, the water in the gauge glass should be about the same temperature as the water in the tank. If the gauge glass fails to heat as described some obstruction is preventing a free flow of steam down through the metal tube in the gauge glass and out through the trap chamber attached to the bottom gauge fitting. An over-expanded or faulty trap element (G), Figure 1, may prevent steam from passing through the chamber. If steam passes out through the bleeder port (M), Figure 2, continuously the trap element (G) is not expanding, or dirt or scale is preventing the proper closing of the port (L). To check trap element, disconnect the tubing (D) between the bottom gauge fitting and the top of the chamber (E) and unscrew the cover. To check the tubing inside the gauge glass, while the tubing from the bottom fitting is disconnected, open the top gauge valve with pressure in the tank. Steam should flow through the port on the lower gauge fitting.

SAFETY (POP) VALVES - On pressure sterilizers they are for the purpose of releasing excess pressure within the sterilizer. They are safety devices, as the name indicates, and should, therefore, be frequently inspected and tested.

Safety valves should be tested daily by simply raising the lever arm (A) of the valve when there is pressure in the sterilizer to see if steam will escape freely through the valve. When the arm (A) is released, the valve should close promptly and tightly.



The safety valves are set and sealed at the factory to release at about 22-25 lbs. pressure in the sterilizer. The setting should not be changed unless checked by means of an accurate steam pressure gauge. If necessary to change the adjustment, proceed as follows:

Remove the seal from the cross pin (L) in the end of the release lever and remove the pin and lever (A). Loosen the two set screws (K) in the bottom of the cap and remove the cap from the top of the valve.

The pressure at which the safety valve releases is determined by the tension of the spring (B) which is adjusted by the screw (C) at the top of the valve. Locknut (D) is provided to lock the adjusting screw (C) in place after the proper adjustment has been made. If the adjusting screw (C) cannot be screwed down sufficiently to produce the required pressure, a new spring must be installed.

If the safety valve leaks steam continuously, the trouble is usually caused by dirt or scale lodging in the valve seat (M), preventing the valve disc (E) from seating properly. When this occurs, the valve should be removed from the sterilizer, taken apart and carefully cleaned.

DIRECTIONS FOR CLEANING VALVE SEAT - Remove the seal and set screw (F) at the side of the valve and unscrew the upper shell (G) from the lower part (H). Clean the valve disc (E) and the valve seat (M). The ring nut (J) regulates the differential between the releasing and closing pressures. This differential which should be about two pounds, can be regulated by turning the ring nut (J) to the right or to the left through the opening for the set screw (F), bringing the nut closer to or farther away from the valve disc. Replace the set screw (F) when properly adjusted, locking the ring nut (J) in its correct position.

If the valve leaks because of a worn seat or disc, they may sometimes be successfully ground in with a fine valve grinding compound.

OIL CHECK FOR INSTRUMENT AND UTENSIL STERILIZERS - The cover and tray of Instrument and Utensil sterilizers are lowered easily and silently by means of the oil check connected to the cover lift rod at the side of the sterilizer. The check consists of a perforated plunger operating in a cylinder of oil. The cylinder is filled with oil and the plunger is adjusted at the factory. With ordinary use, the check should retain the oil and adjustment without further attention for years.

If the cover of the sterilizer should close too rapidly or too slowly, the speed may easily be adjusted as follows: Remove the hinge pin (B) at the end of the plunger rod (C), push plunger to bottom of cylinder, and rotat the rod until the adjusting nut (D) slips into the slot (E) in the bottom head of the cylinder. After the nut (D) is in the slot (E), rotating the plunger rod to the right will retard the speed of the check, and rotating to the left will increase the speed. Turn the rod about a quarter of a turn and then replace the hinge pin (B) and test the action.

In after years of service, the oil seal (F) should fail to retain the oil, it can be replaced with a new one by taking off the cylinder cap and removing the two round head machine screws which hold the oil seal in place.

If necessary to add or to replace the oil in the cylinder, unscrew the cylinder cap and use only new high grade medium motor oil.

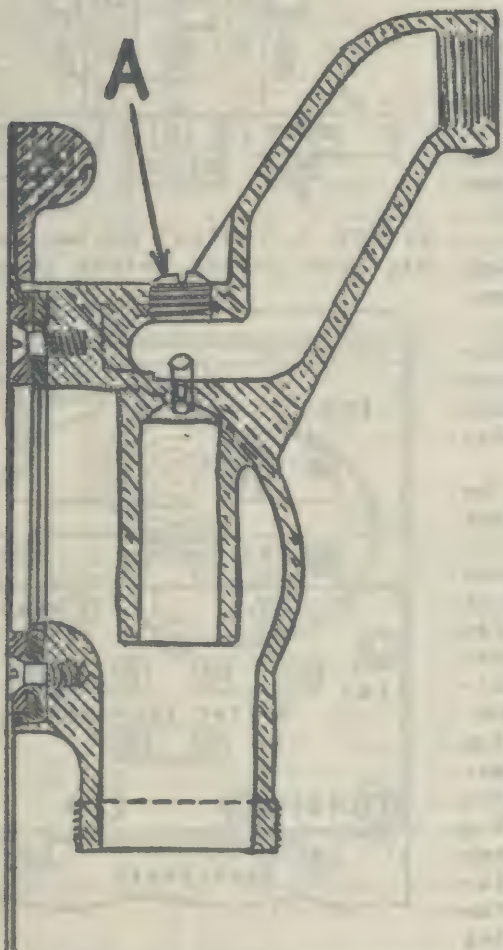
VENT-O-STAT STEAM CONTROL, DIRECTIONS FOR CARE AND MAINTENANCE - The Vent-O-Stat steam control is installed on steam heated nonpressure instrument or utensil sterilizers to automatically regulate the flow of high pressure steam to the heating coil according to the need for heat in the sterilizer. The control consists of a packless steam control valve installed on the steam supply line between the steam supply valve and the heating coil, and is operated by the temperature of the exhaust steam as it enters the water fill fitting attached to the back of the sterilizer.

When the water in the sterilizer is below the boiling point, the control valve is wide open allowing full supply of steam to the heating coil. As the water in the sterilizer begins to boil, the steam generated in the sterilizer enters the water fill fitting, and heats the bulb of the power element installed in it. When properly adjusted, by the time the sterilizer and water fill fitting are thoroughly heated, a pressure is created in the bulb which causes the diaphragm in the control valve to expand, shutting off the supply of steam to the heating coil. A small adjustable bypass around the valve seat then admits sufficient steam to keep the water in the sterllizer boiling gently. The bypass may be adjusted for any desired rate of boiling and its setting will depend upon the size of the sterilizer

and the amount of water used in sterilizing.

When the cover is opened, or fresh water is added, or a load of instruments or utensils are placed in the sterilizer, the temperature of the power element drops, allowing the diaphragm to contract, and the control valve to open to allow full steam supply to the heating coil until boiling is resumed. When properly adjusted, the control valve should open within approximately 30 seconds after the cover is opened or fresh water is added. The valve should close within approximately 30 seconds after the apperance of steam from under the cover. During the normal operation of the sterilizer, if the cover is kept closed after boiling has once started, the control valve should not reopen during the sterilizing period. The bypass will supply all the steam necessary to maintain positive boiling temperatures during the period.

WATER ASPIRATOR - The aspirator consists of a water-operated ejector which draws off and condenses the waste steam from the instrument or utensil sterilizer, the water and condensation being drained into the WATER WASTE line on the sterilizer. The use of the ASPIRATOR eliminates the use of steam vent lines to the outside air for disposing of the waste steam from the sterilizer.



DIRECTIONS FOR OPERATING ASPIRATOR: The aspirator should not be started or used unless steam is escaping from under the cover of the sterilizer. To start the aspirator, open the valve marked WATER SUPPLY (WS) attached to the fitting in the center at the back of the sterilizer. A few seconds will be required to start the removal of the steam. If the aspirator will not take care of all the steam that is being generated in the sterilizer, reduce the heat being used. Boiling violently is not necessary for sterilization, and is a waste of heat. Close the WATER SUPPLY valve on the aspirator at the same time the heat is turned OFF on the sterilizer.

MAINTENANCE - Not less than twenty (20) pounds water pressure should be available at the aspirator for most satisfactory results. If the aspirator ceases to work after a time, there is probably dirt in the jet opening. To clean jet remove the plug (A) at the top of the aspirator, and clean out the jet with a wire. If the dirt cannot be removed this way, the aspirator must be removed and cleaned out from the waste (lower) side of the fitting.

DIRECTIONS FOR REMOVING OR REPLACING ELECTRIC HEATING UNITS (with Type G or H Low Water Cutout on Standard Sterilizers) - The Type G (1 lever) or Type H (2 levers) low water cutout is mounted on the back plate directly over the heating unit and both may be removed from the sterilizer as a unit without disturbing the adjustment of the cutout. When it is necessary to remove the heating unit for cleaning or replacing, proceed as follows:

TO REMOVE HEATING UNIT FROM PRESSURE STERILIZERS:

1. Disconnect the electric power supply (open line switch, pull line fuses, or pull power supply plug) to sterilizer.
2. Remove the sheet metal cover from heater head assembly.
3. Disconnect the cable wires from the heater terminals and cutout switch, tagging each as to its proper location to prevent mistakes when replacing.
4. Loosen conduit connection to heater head assembly.

5. With an end socket wrench remove the eight hexagon nuts or capscrews (A Fig. 2) which hold heater to sterilizer. Then with a board or bar placed behind the back plate, carefully pry the heater assembly loose from the sterilizer. Considerable pressure may be necessary to break gasket loose. Then pull heater straight forward.

FIGURE 1: Type H Cutout switch.

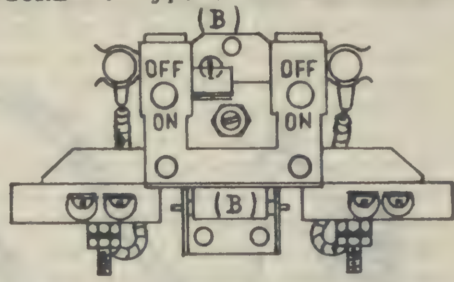
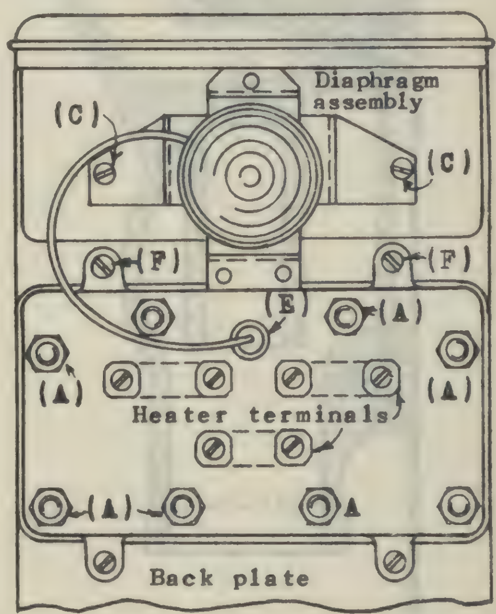


FIGURE 2: (below) Heater Assembly with cutout switch removed.



TO CLEAN HEATING UNIT - See suggestions in Directions. Interior of sterilizer may now be cleaned through heater opening.

TO INSTALL NEW HEATING UNIT - If necessary to install new heating unit, proceed as follows:

1. Remove the two screws (C-Fig. 2) holding cutout to back plate and then pull diaphragm tubing and bulb straight out from contact tube (E). CAUTION: Do NOT kink, bend sharply, flatten or cut the small tubing.

2. Remove the four screws (F) holding the heater to the back plate. Then remove heater from back plate.

3. Place new heating unit in position, replace screws (F) in back plate, slip bulb of diaphragm in contact tube, pushing it in as far as it will go. Replace screws (C). Be sure diaphragm tubing does not contact heater terminals to cause a short circuit. CAUTION: If heating unit has burned out from overheating (as shown by melted metal at any point) always install a new diaphragm with the new heating unit. Installing a new heating unit with a defective diaphragm annuls any low water protection from the cutout. Action of the diaphragm may be quickly checked by holding the bulb in a gas flame for a few moments, heating to 300° or until the diaphragm expands (maximum expansion 1/8"). To install new diaphragm, simply remove the three screws (B Fig. 1) holding switch to diaphragm plate and the small nut on the back of the plate. If the gasket is damaged in removing heating unit, use a new gasket when replacing and remove all traces of the old gasket from both heater and mounting casting before replacing the unit. When through test cutout.

ON NON-PRESSURE STERILIZERS - The heating unit may be cleaned from the inside of the sterilizer after tray is removed. A heating unit is replaced in the same general manner as described above.

DIRECTIONS FOR ADJUSTING TYPE J PRESSURE AND TEMPERATURE CONTROL SWITCHES - Type "J" control switches are made in two models. The PRESSURE control switches are connected directly to the sterilizer by piping and are operated by the pressure in the sterilizer. The TEMPERATURE control switches are operated by the pressure

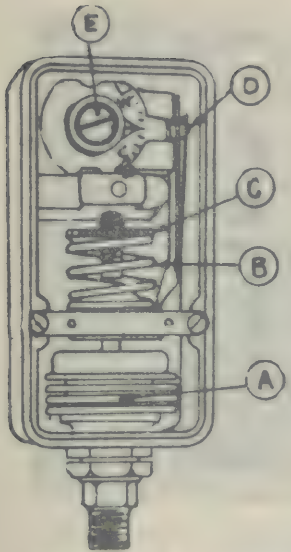


Figure 1.
Type J switch with cover removed and without external adjustment.

created in a sealed power element consisting of the expansion element (A, Fig. 1), a bulb placed at the point of control and connecting tubing, all filled with a liquid. When the bulb is heated, pressure is created in the whole element, the expansion element (A) expands in proportion to the pressure and operates the switch contacts (D).

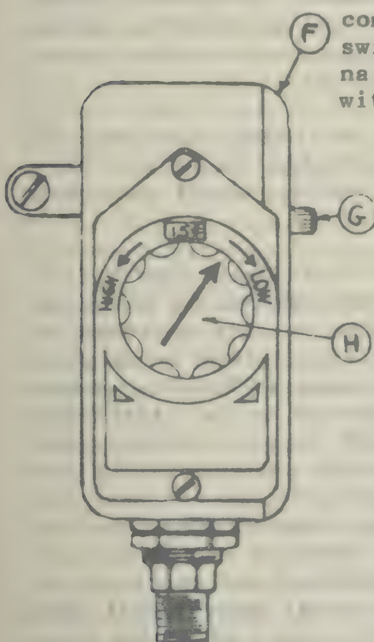
TO ADJUST OPERATING POINT - The temperature or pressure at which these switches operate is controlled by the pressure exerted by the spring (B) against the element (A). The greater the pressure, the higher the operating point. On switches equipped with the external adjustment (see Fig. 2), the operating point is adjusted simply by turning the knob (H, Fig. 2) as indicated.

To adjust switches *not* equipped with external adjustment (see Fig. 1) the adjustment is made by simply rotating the knurled nut (C). To open switch remove the cover (F) by loosening the screw (G). To raise operating point turn nut (C) to left to increase pressure on spring. To lower, reverse.

CAUTION - The nut and spring are part of the electrical circuit. Turn off power to sterilizer when making adjustment or turn the nut with a piece of fibre or with an insulated screw-driver. Do not turn more than ¼ turn at a time. Make adjustment and let switch operate automatically a few times before changing.

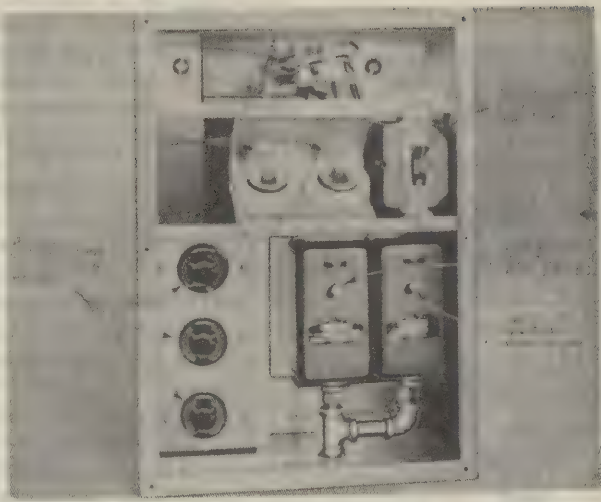
NOTE: On pressure switches connected to sterilizers with long tubes, the operating point of switch will be affected by the amount of condensation in the tube. As the sterilizers are used, the tube gradually becomes filled with condensation and until filled, the operating point of the switch will gradually change a little. This may be eliminated on new sterilizers by filling the connecting tube with water when installed.

Below: Figure 2.
Switch with external adjustment



TO ADJUST OPERATING DIFFERENTIAL - The differential between the opening and closing points of the switch is controlled by a pointer under the screw (E). Turning this pointer changes the distance between the armature and the end of the magnet around the screw. To change differential, loosen screw (E), and turn pointer under it. To reduce differential turn pointer toward "C" bringing magnet away from armature. To increase, turn pointer toward "W", decreasing the space. Then tighten screw (E). A small differential is preferred. On switches equipped with external adjusting know, the differential adjustment is sealed and should not be changed. Keep cover on switches tightly closed at all times.

AUTOMATIC ELECTRIC CONTROL - An automatic temperature and pressure control is provided for electrically operated pressure sterilizers. This control is



equipped with a sensitive adjustable pressure regulator that actuates a magnetically operated mercury tube relay switch which is installed on the power line to the electric heater. When the temperature in the sterilizer is below the correct sterilizing temperature the control regulates the heating system so that the electric heater is working at full capacity. As soon as the proper pressure and temperature has been obtained the control will then automatically regulate the electric current to the heating unit so that a constant temperature is maintained in the sterilizing chamber during the sterilizing period. A control of this type is available so that the dressing sterilizer may be operated at two different pressures. By simply throwing a switch the control can be set instantly to operate the sterilizer at a pressure of 15 pounds for the sterilization of rubber gloves or set at a 20 pound pressure for the sterilization of other surgical supplies. On water sterilizers only one pressure switch is used for each tank. This is set at 20 pounds.

To make adjustments on these pressure switches all it is necessary to do is to turn the adjusting knob clockwise to increase the pressure at which the switch opens, counterclockwise to decrease the pressure at which it opens. Sometimes these knobs will be found on top of the switch rather than on the face as shown in the accompanying illustration.

Mercury switches control the current to the heating elements. They are tilted to the on and off positions by the solenoid.

When the sterilizer line switch is turned on, the solenoid is energized and it tilts the mercury switches to the "on" position, thus supplying current to the heaters. When the proper pressure is reached in the sterilizer the pressure causes an expansion element in the Penn switch to open contacts and break the solenoid circuit, thus de-energizing the solenoid and permitting the mercury switches to tilt back to the "off" position and shut off the heaters. As the pressure drops, the contacts in the Penn switch again closes and energizes the solenoid turning the mercury switches "on". This process supplies enough current to the heaters to maintain the desired pressure in the sterilizer and continues as long as the sterilizer is turned on. Should the low water cut-off open it will also interrupt the solenoid circuit and cause the heaters to be turned off, thus protecting them from damage.

OPERATION AND ADJUSTMENT OF TYPES G AND H MERCURY TUBE LOW WATER CUTOUT SWITCHES - Mercury tube low water cutout switches are made in two general types: TYPE "G" with one control lever having one or two mercury tubes and is used chiefly on sterilizers having automatic pressure or heat controls; TYPE "H" with two control levers and two or three mercury tubes for providing two or three heats on sterilizers equipped with manual control only.

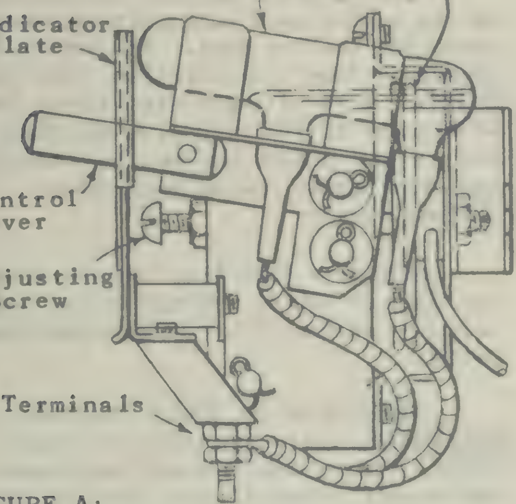


FIGURE A:
Side View of switch in ON position.

On both types of switches the tubes may be operated manually independently of the automatic trip. In case of low water, excessive lime deposit on the heaters, or whenever the temperature of the heating units rises above a safe level, the expansion of the diaphragm automatically trips either or both control levers to the off position and shuts off the heating circuit.

Figure B shows the correct position of the trip plates in the closed position during sterilization. When the heating unit is cold and the cutout trip is closed, the end of the horizontal trip plate (3) should project beyond the face of the vertical contact plate (4) about 1/16". During the sterilizing period if the heating unit is free of lime and completely covered with water, there should not be sufficient movement of the diaphragm to trip the switch open. The maximum expansion of the diaphragm is about 1/8".

In case of low water or excessive lime deposit, the excess heat in the heating units causes the diaphragm (6) to expand. As it expands, the contact pin (5) pushes the contact plate forward until the top end slips out from under the end of the horizontal trip plate (3) allowing the trip plate to drop as shown by the dotted lines in Fig, B. at the same time tilting the mercury tubes to the OFF position.

After the heating unit has cooled, the diaphragm contacts and trip plate may be reset by raising either switch control lever. The amount of overlap of the trip plates is controlled by the adjusting screw (2). CAUTION: In adjusting, the movement required to trip the switch must be less than the maximum expansion of the diaphragm.

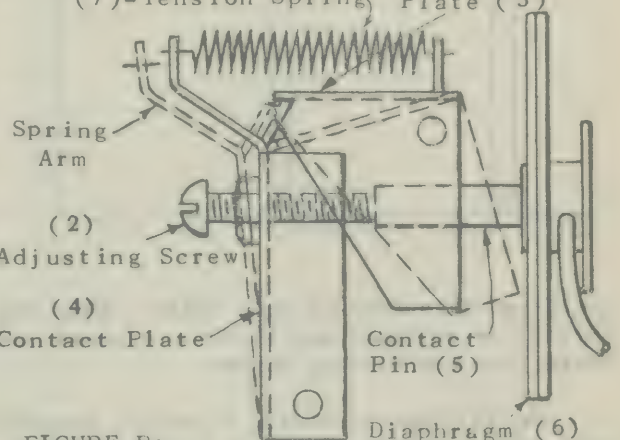
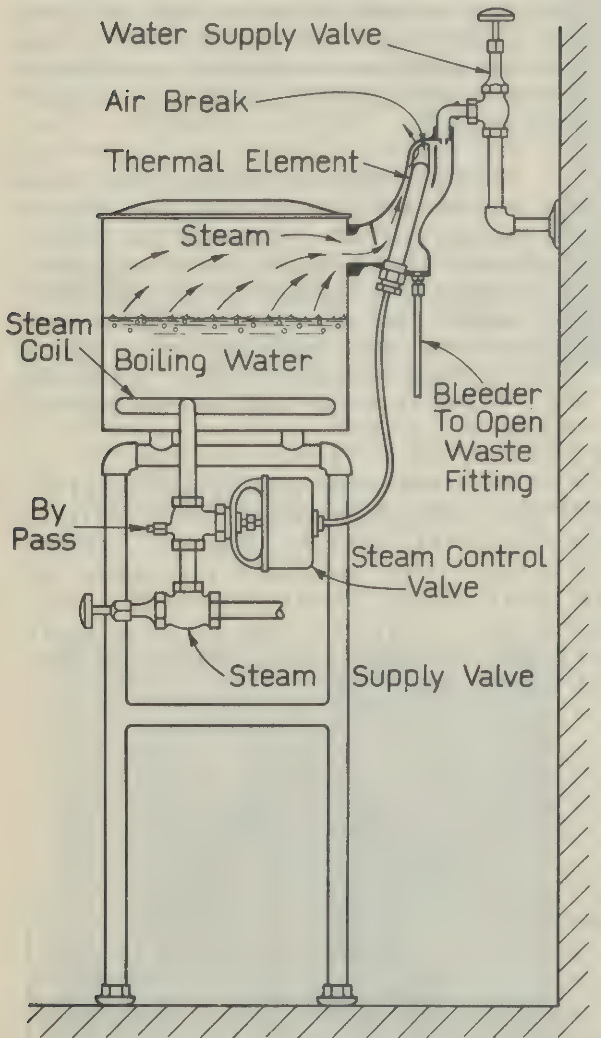


FIGURE B:
Adjustment of Trip Plates.
(solid lines show closed position)

The spring (7) holds the trip plates in position and also tilts the mercury tubes to the OFF position when the switch is tripped by the expansion of the diaphragm. Neither switch lever will

stay up in the ON position when the trip plates are open. After the trip has been reset, the mercury tubes may be manually operated without disturbing the adjustment of the screw (2).



The cutout switch is mounted on the heater head back plate directly above the heating unit. The switch is removable from the sterilizer with the heating unit without disturbing the adjustment of the cutout, or the cutout switch and diaphragm may be removed from the heater heater headwithout the adjustment

CAUTION - When lime deposit trips the switch open, DO NOT reset adjusting screw (2). CLEAN HEATING UNITS.

VENT-O-STAT HEAT CONTROL - For Instrument and Utensil Sterilizers - On steam heated instrument and utensil sterilizers, the thermal element is a part of a thermostatically operated steam control valve, which regulates the flow of steam to the heating coil. An adjustable bypass valve regulates the flow of steam during the sterilizing period.

On gas heated instrument and utensil sterilizers, the control is practically identical to that used on steam sterilizers, except that the control valve regulates the flow of gas to the gas burners. An adjustable bypass prevents complete shutting off of the gas supply and maintains a low heat pilot flame.

On electrically heated instrument and utensil sterilizers, the thermal control unit is an adjustable sensitive thermostat which controls the operation of a mercury tube relay. When the water starts to boil the main heating circuit is off and one heating element maintains a slow boil in the sterilizer during the sterilizing period.

On all Vent-O-Stats, a manual shut-off of the heating medium is provided, independent of the automatic control.

CHAPTER II

STERILIZERS

SECTION 17a

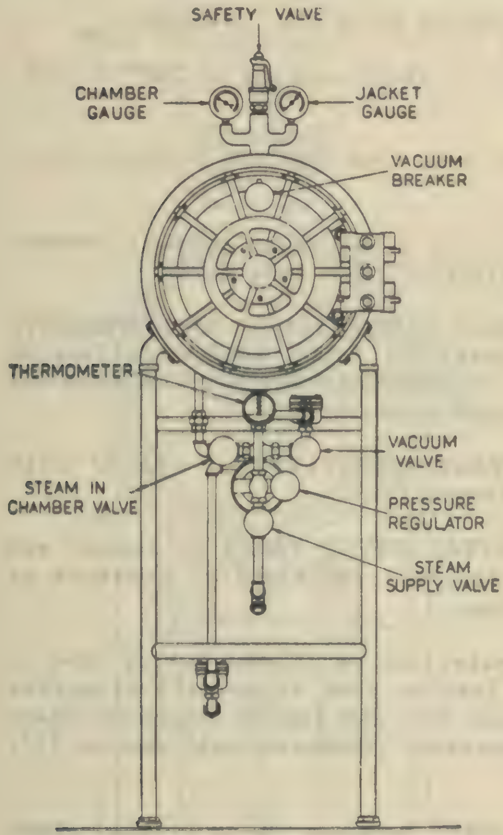
SPECIAL PARTS SECTION
- SCANLAN MORRIS STERILIZER -
Operating Instructions

OPERATING DIRECTIONS
EXPOSED TYPE AUTOCLAVE - DIRECT STEAM HEATED

RECOMMENDED EXPOSURES - For dressings, linen, drums, etc. requiring penetration: Sterilize not less than 30 minutes at 250° F. or over with the pressure regulator set at HIGH (adjusting handle turned clear in) for 20 lb. operation.

For rubber goods, instruments, etc. not requiring penetration of steam: Sterilize 15-20 minutes at not less than 245° F. with regulator set at LOW (adjusting handle turned clear out (counter-clockwise) for 15 lb. operation.

For solutions: Sterilize 20-30 minutes at LOW at not less than 245° F. Do not draw a vacuum or exhaust chamber after sterilizing solutions. (See note below.)



1. *START WITH ALL VALVES CLOSED.*

2. Open Steam Supply Valve.

3. Place materials in sterilizing chamber taking care to distribute load so that steam will circulate freely. Close door and tighten handwheel. Unnecessary tightening will shorten the life of the gasket.

4. When *JACKET GAUGE* (right) shows recommended sterilizing pressure, open *VACUUM VALVE*, and then *STEAM-IN-CHAMBER VALVE* for initial vacuum of 8-10 inches. Close *VACUUM VALVE* when maximum vacuum is indicated on the *CHAMBER GAUGE* (left).

5. Steam pressure in chamber is indicated by the *CHAMBER GAUGE*. The minimum temperature in the chamber is indicated on the thermometer (under door). Start timing sterilizing period when thermometer shows recommended minimum temperature.

6. At end of sterilizing period, open *VACUUM VALVE* for drying vacuum in chamber. Pressure in chamber will drop to zero (see *CHAMBER GAUGE*) and then to *VACUUM*. Maintain a vacuum of 6 to 10 inches for 5 to 10 minutes according to the size and density of the load to dry materials. Dense large bundles will require longer drying.

7. After drying, close *STEAM-IN-CHAMBER VALVE* and then *VACUUM VALVE*. Open vacuum breaker valve in door to relieve vacuum in chamber. When *CHAMBER GAUGE* indicates zero, the door may be opened. Leave door open about 1" for a few minutes before removing materials.

8. When through sterilizing for the day, close *STEAM SUPPLY VALVE* tightly. CAUTION: In sterilizing solutions, *DO NOT* draw a vacuum or exhaust chamber after sterilizing. After sterilization, simply close the *STEAM SUPPLY VALVE* leaving other valves as they were and allow the sterilizer to cool down gradually. Do not open door until *CHAMBER GAUGE* indicates *ZERO*.

OPERATING DIRECTIONS HIGH SPEED INSTRUMENT AUTOCLAVE
DIRECT STEAM HEAT

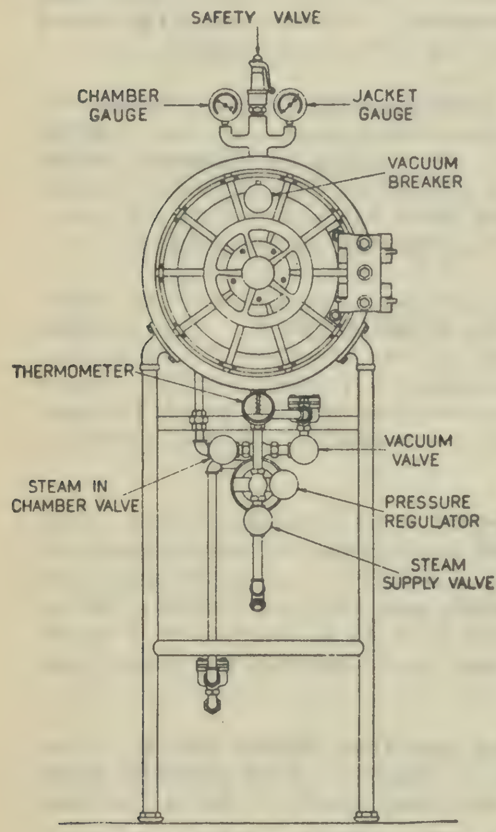
This autoclave may be operated at any desired pressure from 15 to 27 lbs. The pressure in the sterilizer is varied by turning the adjusting handle on the pressure regulator as required. When properly adjusted, the regulator will maintain a pressure of 27 lbs. in the sterilizer when the adjusting handle is turned clear in (clockwise); or 15 lbs. when turned clear out (counter-clockwise); or 20 lbs. about half way between the two limits.

SUGGESTED MINIMUM EXPOSURES FOR STERILIZATION - For *LINENS, DRESSINGS, DRUMS,* etc. (requiring steam penetration); Not less than 250° (on thermometer under door) for 30 minutes using 20 lbs. pressure.

Sterilize *RUBBER GLOVES* from 15 to 20 minutes at 15-16 lbs. pressure.

For *INSTRUMENTS, UTENSILS, GLASSWARE,* etc.; 15-20 minutes at 245° F. (15-16 lbs.)

Sterilize *SOLUTIONS* 20-30 minutes at not less than 245° F. (15-16 lbs. Pressure).



Do *NOT* draw a vacuum or exhaust chamber after sterilization. See Note below.

For *SPEED STERILIZATION OF INSTRUMENTS* at 27 lbs. pressure, follow recommendations of local staff. Instruments should be scrubbed and properly packed in chamber.

1. TO OPERATE STERILIZER - (Start with all valves closed.)

2. Open *STEAM SUPPLY VALVE* to jacket and set steam regulator for required pressure as suggested above.

3. Place materials in chamber taking care to distribute load so that steam will circulate freely. Close door and tighten handwheel steam tight. Unnecessary tightening will shorten life of gasket.

4. When *JACKET* pressure gauge (right) shows recommended pressure, open *VACUUM VALVE* and then *STEAM-IN-CHAMBER VALVE* for initial vacuum of 8-10 inches, to assist in removing air from chamber. When maximum vacuum is indicated on *CHAMBER GAUGE* (left), close *VACUUM VALVE*.

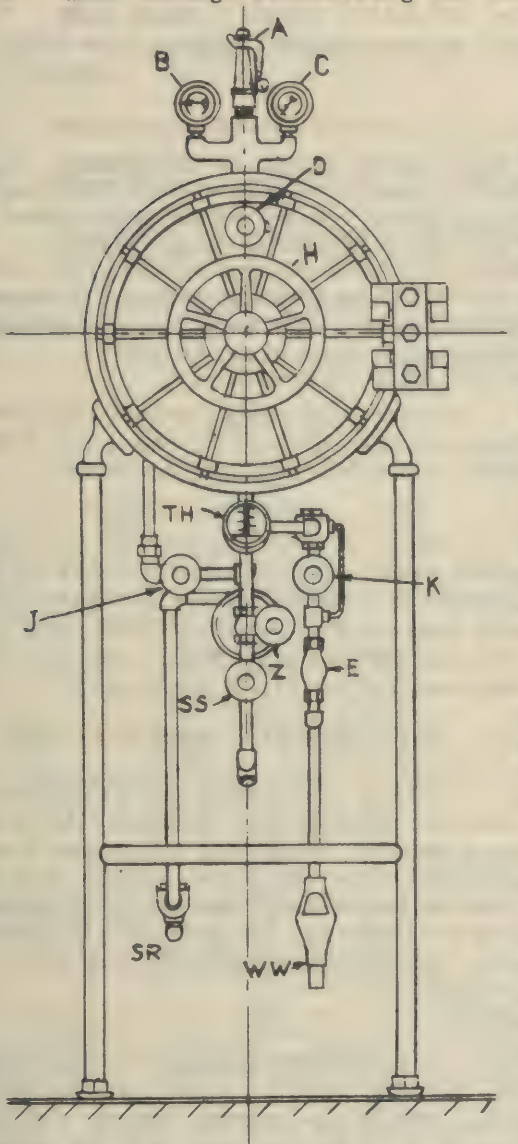
5. Steam pressure in chamber is indicated by the *CHAMBER GAUGE* (left). The minimum temperature in the chamber is indicated by thermometer under the door. Start timing sterilizing period when thermometer shows recommended minimum temperature.

NOTE: After sterilizing solutions do *NOT* exhaust chamber or draw a vacuum; simply close the *STEAM SUPPLY VALVE* leaving other valves as they were and allow sterilizer to cool slowly. Do *NOT* open door until chamber gauge indicates zero.

6. At end of sterilizing period, open *VACUUM VALVE* again to form drying vacuum in chamber. (See note on preceding page.) Pressure on chamber gauge will drop to zero and then indicate vacuum. Maintain a vacuum of up to 10" for 5-10 minutes according to the size and density of the load. Dense large bundles require longer drying.

7. After drying, close *STEAM-IN-CHAMBER VALVE* and then the *VACUUM VALVE*. Open vacuum breaker valve in door to relieve vacuum in chamber. When *CHAMBER* gauge indicates zero, the door may be opened. Leave door open about 1" for a few minutes before removing materials from chamber.

8. When through sterilizing for the day, close *STEAM SUPPLY VALVE* tightly.



EXPOSED TYPE "D" AUTOCLAVE DIRECT STEAM HEATED WITH WATER EJECTOR

1. Start with all valves closed (D, J, K, SS). Place articles to be sterilized in chamber and close the sterilizer door steam tight, turning the handwheel (H) to the right. Be sure the radial locking bars are in place under the door collar before rotating the handwheel.

2. Open *STEAM SUPPLY VALVE* (SS) several turns. For 20 lbs. pressure in jacket, turn handle (Z) on the control valve clear in (clockwise). For 15 lbs. operation for sterilization of gloves, turn handle to left (counter-clockwise). See other Directions for adjustment of the steam control valve. When the jacket pressure gauge (C) indicates 20 lbs. (or 15 lbs.), the sterilization process may be started. For dressings, linens, etc., proceed as follows:

3. Secure from 6 to 10 inch vacuum in chamber as shown by left hand gauge (B) by opening *VACUUM VALVE* (K) only, maintain two or three minutes, then close *VACUUM VALVE* (K).

4. Admit steam into chamber by opening the *STEAM-IN-CHAMBER VALVE* (J). As steam enters chamber, the pointer on chamber gauge (B) will move up to zero, and then gradually move until both gauges indicate about the same pressure. If steam leaks out from under door, turn handwheel to the right until steam tight.

5. The thermometer (TH) indicates the lowest temperature in the chamber, providing a check on the removal of air and condensation from the chamber. When thermometer indicates a minimum of 250° F., start timing the sterilization period.

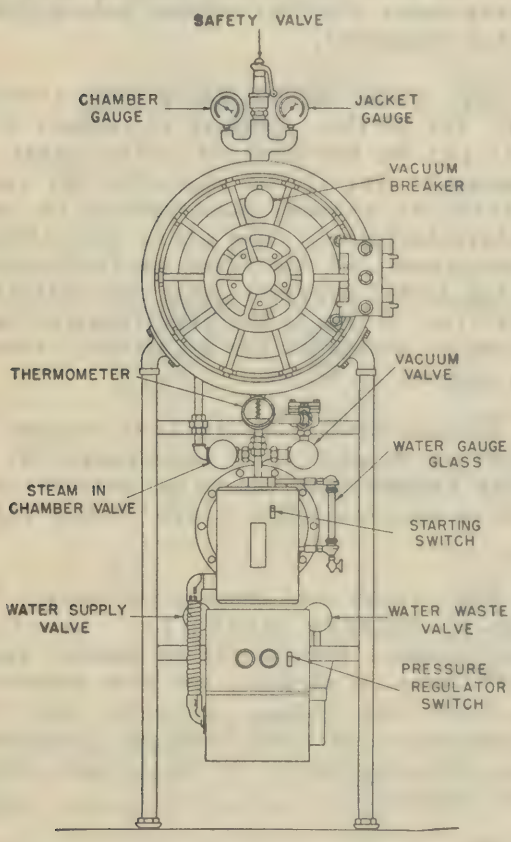
6. After sterilization, close the *STEAM-IN-CHAMBER VALVE (J)*. To exhaust chamber and dry dressings, open the *VACUUM VALVE (K)*. Gauge *(B)* will drop to zero and then indicate 8 to 12 inches of vacuum. Maintain this vacuum for 5 to 10 minutes according to she size and weight of the load in chamber. At end of drying period, close *VACUUM VALVE (K)*. NOTE: When through sterilizing solutions, *DO NOT* open the *VACUUM VALVE (K)*.

7. Open valve *(D)* in door to break vacuum in chamber. When chamber gauge *(B)* indicates zero, the door may be opened. Allow the packs to remain in the chamber for a few minutes with the door partially open for final drying and cooling before removing. When through sterilizing for the day, close the *STEAM SUPPLY VALVE (SS)*.

EXPOSED TYPE "D" AUTOCLAVE - ELECTRICALLY HEATED

START WITH ALL VALVES CLOSED.

BEFORE OPERATING STERILIZER ALWAYS CHECK WATER LEVEL IN GENERATOR. Open *WATER SUPPLY VALVE* and fill generator to within approximately 1 inch from top of gauge glass. Never allow water level to fall below bottom of gauge glass.



To sterilize dressings, linens, dressing drums, etc., set *PRESSURE REGULATOR SWITCH AT "HIGH"*.

To sterilize rubber goods, solutions, instruments, utensils, etc., set *PRESSURE REGULATOR SWITCH* at *"LOW"*.

(When properly adjusted the *PRESSURE REGULATOR* should maintain approximately 18-20 pounds pressure (255-259 degrees F.) at the *"HIGH"* setting; and approximately 15 pounds pressure (250 degrees F.) at *"LOW"* setting.)

1. Raise *STARTING SWITCH* to *"ON"*.

2. Place materials in sterilizing chamber taking care to distribute the load so that steam will circulate freely and penetrate the packs. Close door and tighten handwheel. Unnecessary tightening will shorten the life of the gasket. See that *VACUUM BREAKER* on door is closed.

3. When 15-20 pressure is indicated on *JACKET GAUGE*, open *VACUUM VALVE* then *STEAM-IN-CHAMBER VALVE*. A vacuum of 5 inches or more will be secured and indicated on *CHAMBER GAUGE*. After maximum vacuum has been reached close VACUUM VALVE.

4. Pressure in sterilizing chamber will then rise to level set by *PRESSURE REGULATOR*. When the *THERMOMETER* reads 240 degrees F., timing of the sterilizing may start.

5. When sterilizing period has been completed, open *VACUUM VALVE*. Pressure in sterilizing chamber will drop until a vacuum of 5 inches or more is indicated on *CHAMBER GAUGE*. Maintain this vacuum for 5 to 10 minutes, according to size and density of load, to dry dressings.

6. Close *STEAM-IN-CHAMBER VALVE* then *VACUUM VALVE*. Open *VACUUM BREAKER* to relieve any vacuum which would prevent opening of door.

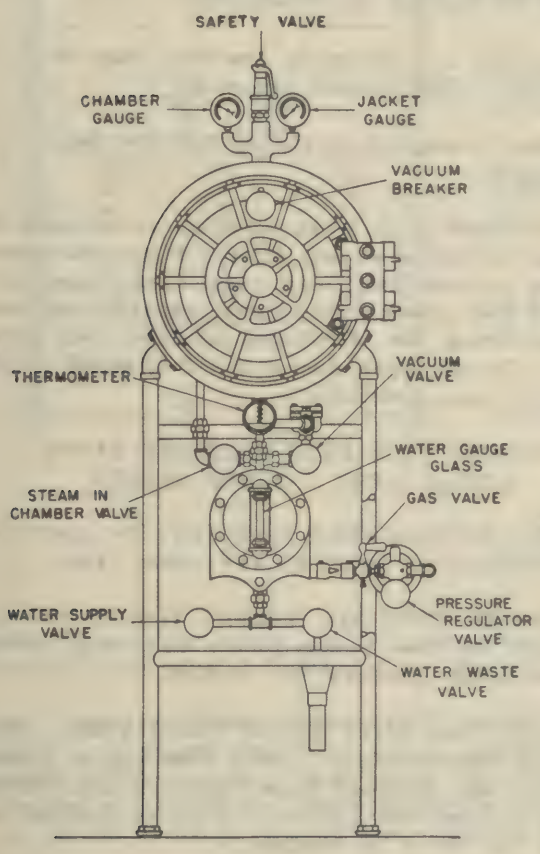
7. When *CHAMBER GAUGE* indicates zero pressure, open door approximately 1 inch beyond door collar. Leave door in this position for a few minutes to further dry dressings.

8. Before sterilizing another load refill generator. Then repeat process.

9. When through sterilizing for the day lower *STARTING SWITCH* to "*OFF*".

CAUTION - In sterilizing solutions *DO NOT* draw a vacuum at any time. After the sterilizing period has been completed, lower *STARTING SWITCH* to "OFF" and leave all valves exactly as they were, allowing the sterilizer to cool down gradually. Do not open door until *CHAMBER GAUGE* indicates zero pressure.

EXPOSED TYPE "D" AUTOCLAVE - GAS HEATED



1. START WITH ALL VALVES CLOSED.

2. *BEFORE OPERATING STERILIZER ALWAYS CHECK WATER LEVEL IN GENERATOR.* Open *WATER SUPPLY VALVE* and fill generator to within approximately 1 inch from top of gauge glass. Never allow water level to fall below bottom of gauge glass.

3. To sterilize dressing packs, drums, etc., turn *PRESSURE REGULATOR* to "*HIGH*".

4. To sterilize rubber goods, solutions, instruments, utensils, etc., turn *PRESSURE REGULATOR* to "*LOW*".

(When properly adjusted the *PRESSURE REGULATOR* should maintain approximately 18-20 pounds pressure (255-259 degrees F.) at the "*HIGH*" setting; and approximately 15 pounds pressure (250 degrees F.) at the "*LOW*" setting.)

5. Light burners under generator.

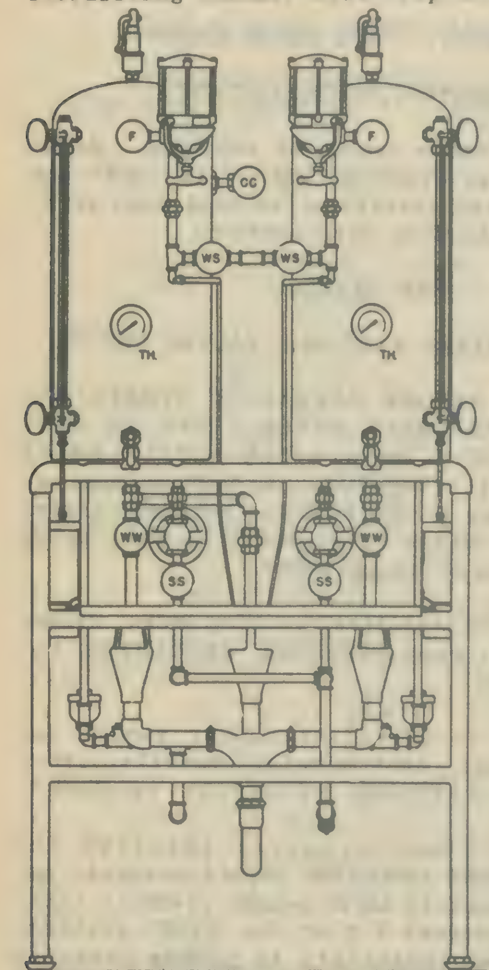
6. Place materials in sterilizing chamber, taking care to distribute the

load so that steam will circulate freely and penetrate the packs. Close door and tighten handwheel. Unnecessary tightening will shorten the life of the gasket. See that *VACUUM BREAKER* on door is closed.

7. When 15-20 pounds pressure is indicated on *JACKET GAUGE* open *VACUUM VALVE*, then *STEAM-IN-CHAMBER VALVE*. A vacuum of 5 inches or more will be secured and indicated on *CHAMBER GAUGE*. After maximum vacuum has been reached, close *VACUUM VALVE*.

8. Pressure in sterilizing chamber will then rise to level set by *PRESSURE REGULATOR*. When the *THERMOMETER* reads 240 degrees F., timing of the sterilizing period may start.

9. When sterilizing period has been completed, open *VACUUM VALVE*. Pressure in sterilizing chamber will drop until a vacuum of 5 inches or more is indicated on *CHAMBER GAUGE*. Maintain this vacuum for 5 to 10 minutes, according to size and density of load, to dry dressings,



10. Close *STEAM-IN-CHAMBER VALVE*, then *VACUUM VALVE*. Open *VACUUM BREAKER* to relieve any vacuum which would prevent opening of door.

11. When *CHAMBER GAUGE* indicates zero pressure, open door approximately 1 inch beyond door collar. Leave door in this position for a few minutes to further dry dressings.

12. Before sterilizing another load refill generator. Then repeat process.

13. When through sterilizing for the day, turn off burners.

CAUTION - In sterilizing solutions, *DO NOT* draw a vacuum at any time. After the sterilizing period has been completed, turn off *BURNERS* and leave all valves exactly as they were, allowing the sterilizer to cool down gradually. Do not open doors until *CHAMBER GAUGE* indicates zero pressure.

EXPOSED TYPE HIGH PRESSURE WATER STERILIZERS - STEAM HEATED

The HOT and *COLD* tanks may be operated individually or both at the same time.

1. START WITH ALL VALVES *CLOSED* except the four on the gauge glass fittings which should remain open at all times unless the gauge glasses are broken.

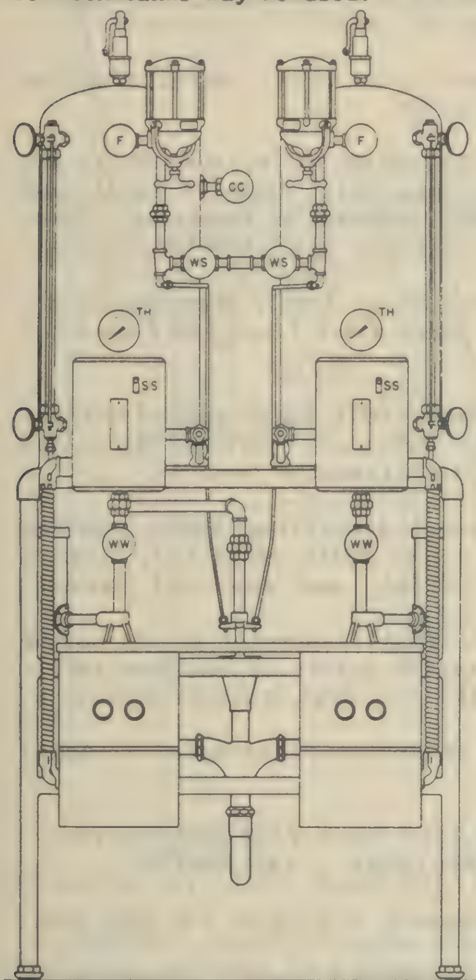
2. TO FILL TANKS - Open *FILTER VALVE* (F) then *WATER SUPPLY VALVE* (WS). When the water column in gauge glass has risen to approximately 1 inch from top of glass, close *WATER SUPPLY VALVE* (WS). When water has drained from filter close *FILTER VALVE* (F). (If the water should not drain from the filter, it is an indication that the bleeder screen or bleeder line to the waste is clogged.)

3. TO STERILIZE WATER - Open *STEAM SUPPLY VALVE (SS).* Temperature of water as indicated by *THERMOMETER* will rise gradually to 250-255 degrees F. and will be held at that level automatically. Flush out draw-off faucets by opening them partly and allowing steam and water to issue into a pitcher for a brief period. Water gauge glasses are sterilized automatically by the Magath SterilGuards. When the sterilizing period has been completed, shut off *STEAM SUPPLY VALVE (SS).*

4. TO COOL WATER IN COLD TANK - Open *COOLING COIL VALVE (CC).* When water has cooled down to desired temperature, close *COOLING COIL VALVE (CC).*

5. TO DISTILL WATER - (The following instructions are applicable only to water sterilizers equipped with Still.)

Water sterilizers are used to create steam for operation of the Still. Either or both tanks may be used.



6. Fill tank to be used. Open *STEAM SUPPLY VALVE (SS).*

7. Open *STILL VALVE (S)* between Still and top of tank. Open Still draw-off faucet and drain any water remaining in reservoir. Leave faucet open with pan placed below.

8. When steam issues freely from faucet, remove pan and place glass flask and funnel beneath faucet.

9. Open *COOLING COIL VALVE* marked *(STILL)* beneath Still reservoir. Collect distilled water as it flows from the faucet.

10. When through distilling, close *STEAM SUPPLY VALVE (SS), STILL VALVE (S), COOLING COIL VALVE (STILL)* and draw-off faucet.

CAUTION: Distilled water should not be considered sterile unless it has been sterilized in flasks in a high pressure autoclave.

Do not store distilled water in Still reservoir.

EXPOSED TYPE HIGH PRESSURE WATER STERILIZERS - ELECTRICALLY HEATED

The *HOT* and *COLD* tanks may be operated indivisually or both at the same time.

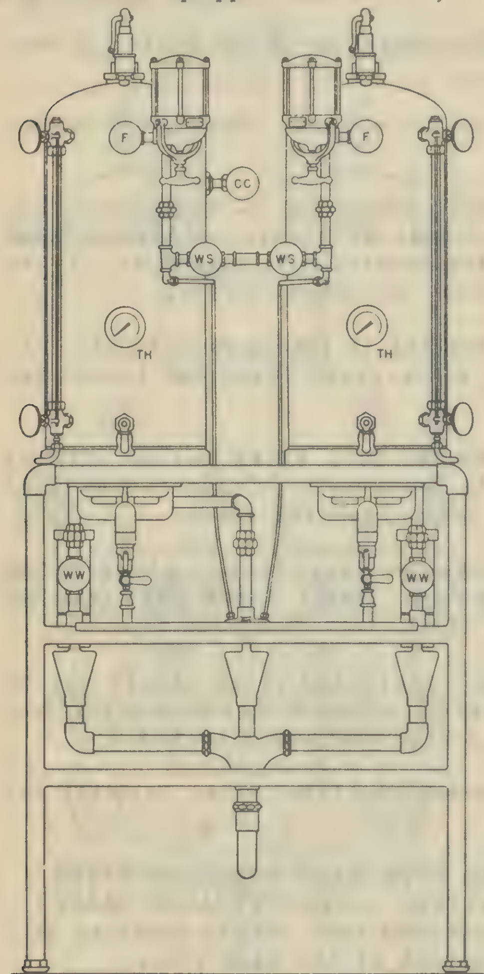
1. *START WITH ALL VALVES CLOSED* except the four on the gauge glass fittings which should remain open at all times unless the gauge glasses are broken.

2. TO FILL TANKS - Open *FILTER VALVE, then WATER SUPPLY VALVE.* When the water column in gauge glass has risen to approximately 1 inch from top of glass, close *WATER SUPPLY VALVE.* When water has drained from filter close *FILTER VALVE.* (If the water should not drain from the filter, it is an indication that the bleeder screen or bleeder line to the waste is clogged.

3. TO STERILIZE WATER - Raise *STARTING SWITCH (SS)* to *ON*. Temperature of water as indicated by *THERMOMETER* will rise gradually to 250-255 degrees F. and will be held at that level automatically. Flush out draw-off faucets by opening them partly and allowing steam and water to issue into a pitcher for a brief period. Water gauge glasses are sterilized automatically by the Magath SterilGuards. When the sterilizing period has been completed, lower *STARTING SWITCH (SS)* to *OFF*.

4. TO COOL WATER IN COLD TANK - Open *COOLING COIL VALVE*. When water has cooled down to desired temperature, close *COOLING COIL VALVE*.

5. TO DISTILL WATER - (The following instructions are applicable only to water sterilizers equipped with Still.)



Water sterilizers are used to create steam for operation of the Still. Either or both tanks may be used.

1. Fill tank to be used. *RAISE STARTING SWITCH (SS)* to *ON*.

2. Open *STILL VALVE (S)* between Still and top of tank. Open Still draw-off faucet and drain any water remaining in reservoir. Leave faucet open with pan placed below.

When steam issues freely from faucet, remove pan and place glass flask and funnel beneath faucet.

3. Open *COOLING COIL VALVE* marked *(STILL)* beneath Still reservoir. Collect distilled water as it flows from the faucet.

4. When through distilling, *LOWER STARTING SWITCH (SS)*, close STILL *VALVE (S)*, *COOLING COIL VALVE (STILL)* and draw-off faucet.

CAUTION: Distilled water should not be considered sterile unless it has been sterilized in flasks in a high pressure autoclave.

Do not store distilled water in Still reservoir.

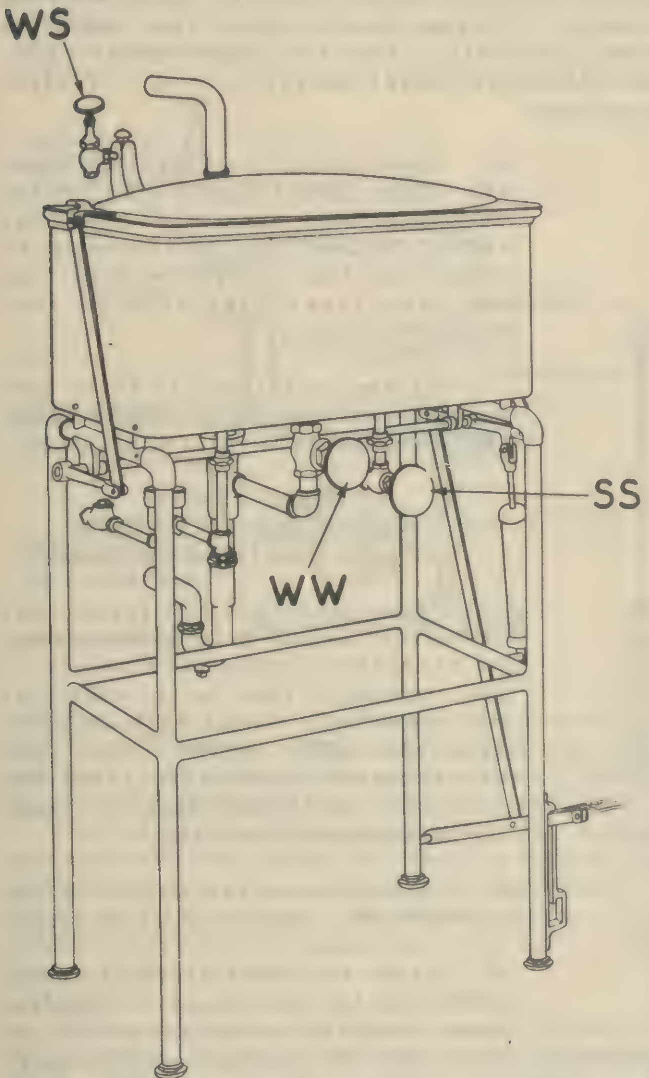
EXPOSED TYPE HIGH PRESSURE WATER STERILIZERS - GAS HEATED

The *HOT* and *COLD* tanks may be operated individually or both at the same time.

1. *START WITH ALL VALVES CLOSED* except the four on the gauge glass fittings which should remain open at all times unless the gauge glasses are broken.

2. TO FILL TANKS - Open *FILTER VALVE*, then *WATER SUPPLY VALVE*. When the water column in gauge glass has risen to approximately 1 inch from top of glass, close *WATER SUPPLY VALVE*. When water has drained from filter close *FILTER VALVE*. (If the water should not drain from the filter, it is an indication that the bleeder screen or bleeder line is clogged.)

3. TO STERILIZE WATER - Light gas burner, turning *GAS VALVE* wide open for maximum heat. Temperature of water as indicated by *THERMOMETER* will rise gradually to 250-255 degrees F. and will be held at that level automatically. Flush out draw-off faucets by opening them partly and allowing steam and water to issue into a pitcher for a brief period. Water gauge glasses are sterilized automatically by the Magath SterilGuards. When the sterilizing period has been completed turn off gas valve.



4. TO COOL WATER IN COLD TANK - Open *COOLING COIL VALVE*. When water has cooled down to desired temperature, close *COOLING COIL VALVE*.

TO DISTILL WATER - (The following instructions are applicable only to water sterilizers equipped with Still.)

Water sterilizers are used to create steam for operation of the Still. Either or both tanks may be used.

1. Fill tank to be used. Light the burner under the tank, turning *GAS VALVE* wide open for maximum heat.

2. Open *STILL VALVE (S)* between Still and top of tank. Open Still draw-off faucet and drain any water remaining in the reservoir. Leave faucet open with pan placed below.

When steam issues freely from faucet, remove pan and place glass flask and funnel beneath faucet.

3. Open *COOLING COIL VALVE* marked *(STILL)* beneath Still reservoir. Collect distilled water as it flows from the faucet.

4. When through distilling, turn off gas burner, *STILL VALVE (S)*, *COOLING COIL VALVE (STILL)* and draw-off faucet.

CAUTION: Distilled water should not be considered sterile unless it has been sterilized in flasks in a high pressure autoclave. Do not store distilled water in Still reservoir.

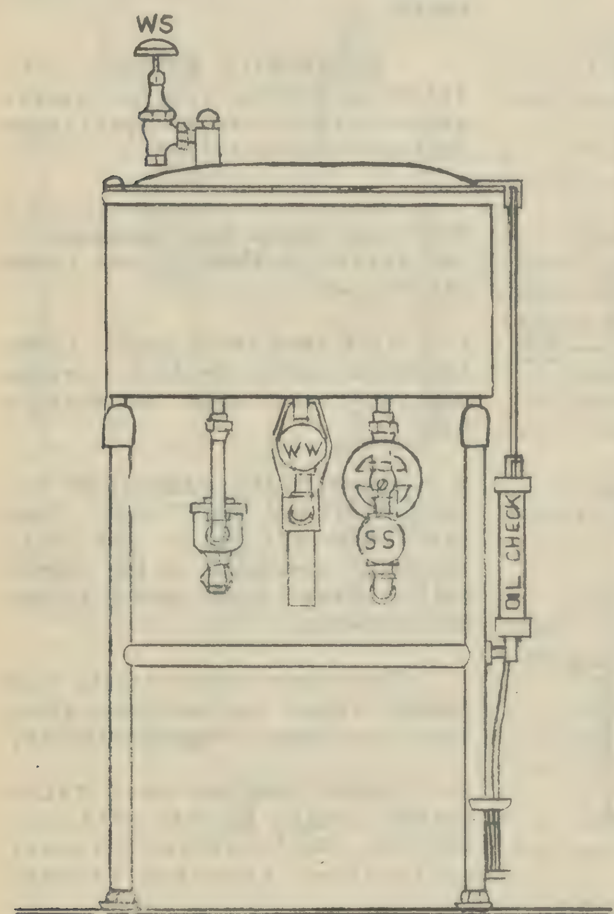
STEAM HEATED INSTRUMENT STERILIZERS
(NON-PRESSURE)

1. Keep all valves closed when sterilizer is not in use. When ready to sterilize, place instruments in the tray and close the cover by releasing the foot lever from

the catch. Open the valve marked *WATER SUPPLY (WS)* at the back of the sterilizer and fill the sterilizer with sufficient water to cover the instruments and tray when the cover is closed.

2. Open valve marked *STEAM SUPPLY (SS)*.

3. After water starts to boil, *STERILIZE* the instruments in boiling water with the cover closed for not less than 20 minutes. If steam should escape from under the cover during the sterilization period, partially close the *STEAM SUPPLY (SS) until* just enough steam is admitted to keep the water gently boiling. Violent boiling is unnecessary and is a waste of heat.



4. When through sterilizing, close the *STEAM SUPPLY VALVE (SS)*, raise the cover and tray with the foot lever, allow the instruments to drain, and then remove the tray from the sterilizer with sterile tray hooks.

If the sterilizer is to be used again soon, the *STEAM SUPPLY VALVE* (SS) may be left partially open.

STEAM HEATED
INSTRUMENT STERILIZER
(Coated Steel Construction)

1. Keep all valves closed when sterilizer is not in use. When ready to sterilize, place instruments in the instrument tray in the bottom of the sterilizer and close the cover. Open the *WATER SUPPLY VALVE (WS)* at the back of the sterilizer and fill with sufficient water to cover the instruments and tray.

2. Open the valve marked *STEAM SUPPLY (SS)* under the sterilizer.

3. After the water starts to boil, *STERILIZE* the instruments in boiling water with the cover closed for not less than 20 minutes. If the sterilizer is equipped with a Vent-O-Stat heat control. the flow of steam will be automatically reduced during the sterilizing period.

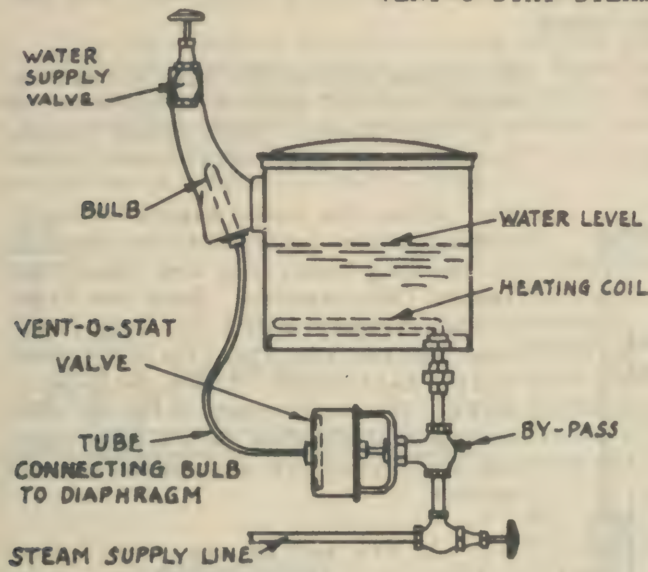
(If the sterilizer is equipped with a water operated aspirator for condensing the excess waste steam, see other directions.

(If sterilizer is not equipped with excess vapor control, and steam escapes from under the cover during the sterilizing period, partially close the *STEAM SUPPLY VALVE* until just enough steam is admitted to keep the water gently boiling. Violent boiling is unnecessary and is a waste of heat.)

4. When through sterilizing, close the *STEAM SUPPLY VALVE (SS)*, raise the cover, lift up the tray of instruments with sterile tray hooks inserted in the handles of the tray, allow the tray and instruments to drain for a moment, and then remove from the sterilizer. If sterilizer is to be used again soon, close cover and leave *STEAM SUPPLY VALVE* partially open.

CAUTION: *On ZINC COATED* steel sterilizers, *DO NOT* use acid for the removal of lime.

VENT-O-STAT STEAM CONTROL



DIRECTIONS FOR CARE AND MAINTENANCE - The A2480 Vent-O-Stat steam control is installed on steam heated non-pressure instrument or utensil sterilizers to automatically regulate the flow of high pressure steam to the heating coil according to the need for heat in the sterilizer. The control consists of a packless steam control valve installed on the steam supply line between the steam supply valve and the heating coil, and is operated by the temperature of the exhaust steam as it enters the water fill fitting attached to the back of the sterilizer.

When the water in the sterilizer is below the boiling point, the control valve is wide open allowing full supply of steam to the heating coil. As the water in the sterilizer begins to boil, the steam generated in the sterilizer enters the water fill fitting, and heats the bulb of the power element installed in it. When properly adjusted, by the time the sterilizer and water fill fitting are thoroughly heated, a pressure is created in the bulb which causes the diaphragm in the control valve to expand, shutting off the supply of steam to the heating coil. A small adjustable bypass around the valve seat then admits sufficient steam to keep the water in the sterilizer boiling gently. The bypass may be adjusted for any desired rate of boiling and its setting will depend upon the size of the sterilizer and the amount of water used in sterilizing.

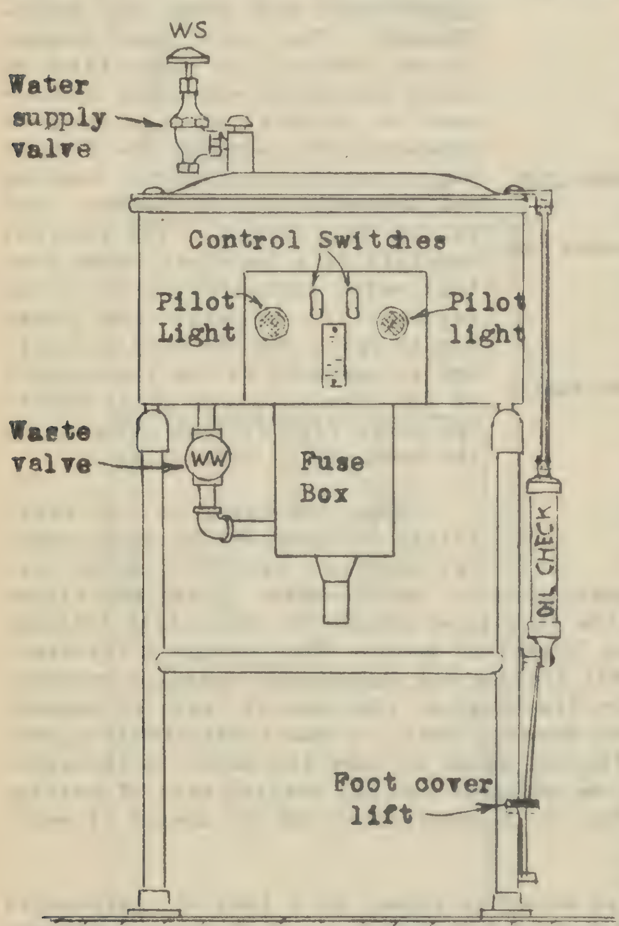
When the cover is opened, or fresh water is added, or a load of instruments or utensils is placed in the sterilizer, the temperature of the power element drops, allowing the diaphragm to contract, and the control valve to open to allow full steam supply to the heating coil until boiling is resumed. When properly adjusted, the control valve should open within approximately 30 seconds after the cover is opened or fresh water is added. The valve should close within approximately 30 seconds after the appearance of steam from under the cover. During the normal operation of the sterilizer, if the cover is kept closed after boiling has once started, the control valve should not reopen during the sterilizing period. The bypass will supply all the steam necessary to maintain positive boiling temperatures during the period.

SPECIAL PARTS SECTION

NON-PRESSURE INSTRUMENT OR UTENSIL ELECTRICALLY HEATED STERILIZERS TYPE H CUTOUT - MANUAL HEAT CONTROL

1. Keep all valves closed when the sterilizer is not in use. Keep the starting switches down *(OFF)* unless there is sufficient water in the sterilizer to completely cover the heating elements.

2. When ready to sterilize, place instruments and other articles in the tray in the sterilizer and close the cover by releasing the foot lever which raises and lowers the cover. Open the *WATER SUPPLY VALVE* at the back of the sterilizer and fill the sterilizer with sufficient water to completely cover the tray and articles in the tray when the cover is closed.



3. Turn on electric heat by raising both control switch levers to *ON* for full heat. Both pilot lights should glow when *FULL* heat is *ON*.

4. *After* the water starts to boil, *STERILIZE* the instruments or utensils in boiling water for not less than twenty (20) minutes. Drop the right switch lever to *OFF* for *LOW* (1/3) heat during the sterilizing period (with left pilot light only on). NOTE: The watts controlled by each switch is indicated on the name plate on the front of the heater head cover.

5. At the end of the sterilizing period, open the cover with the foot lift, raise the tray and instruments above the water line with the tray hooks provided, allow the tray and instruments to drain for a few moments, and then remove from the sterilizer. If through sterilizing turn both switch levers *OFF*.

6. The sterilizer may be drained by opening the *WATER WASTE VALVE* under the sterilizer. See separate directions regarding the care of heating units and the low water cutout assembly. If the water boils away so as to expose the heating elements above the water, the control switches will automatically drop to the *OFF* position shutting off the current to the heating elements. The switch is manually reset but will not stay *ON* until water has been added to entirely cover the heating elements and cool them to their normal working temperature. An accumulation of lime deposit on the elements will also cause the cutout to operate. Keep elements clean and free of lime.

The heating elements may be easily cleaned from the inside of the sterilizer after removing the tray.

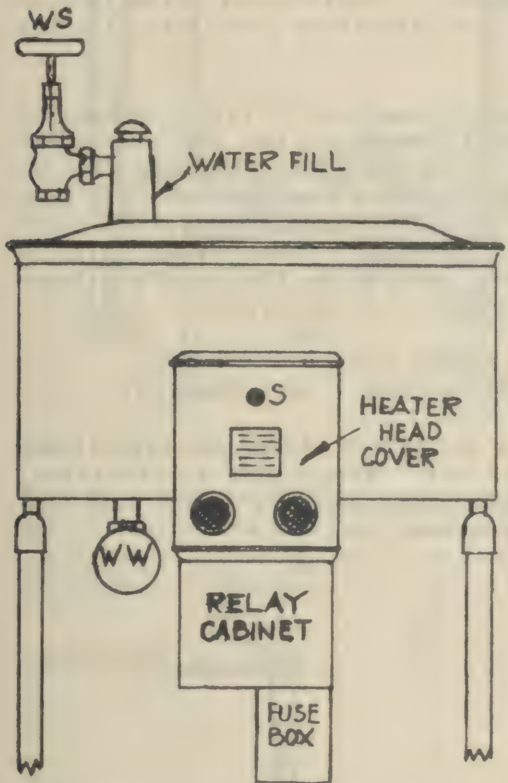
CAUTION - Never turn on electric heat without first checking water level in sterilizer.

INSTRUMENT STERILIZER - UTENSIL STERILIZER
ELECTRICALLY HEATED - VENT-O-STAT HEAT CONTROL

1. Keep all valves closed when the sterilizer is not in use. Keep the starting switch (S) *OFF* (pull out) unless there is sufficient water in the sterilizer to completely cover the heating units.

2. When ready to sterilize, place instruments or utensils in the tray in the sterilizer and close the cover by releasing the foot lever which raises and lowers the cover. Open the *WATER SUPPLY VALVE (WS)* at the back of the sterilizer and fill the sterilizer with sufficient water to completely cover the tray and instruments or utensils when the cover is closed.

3. Turn on electric heat by pushing in the starting switch knob (*S*). Both pilot lamps should glow when starting. As the water in the sterilizer starts to boil, the steam passing out into water fill fitting at the back of the sterilizer, operates a thermostat, which in conjunction with a relay in the relay cabinet under the sterilizer, keeps the water in the sterilizer at the boiling point without the generation of excessive waste steam.



4. After the water starts to boil, *STERILIZE* the instruments or utensils in the boiling water for not less than twenty (20) minutes. At the end of the period, pull out starting switch "S" *to OFF*, open the cover with the foot lift, allow the tray and instruments to drain for a moment and then remove the sterile articles with sterile forceps or tray hooks.

5. The sterilizer may be drained by opening the *WATER WASTE VALVE (WW)* under the sterilizer. The white pilot lamps burn whenever current is on the heating units. See separate directions regarding the care of the heating units and the low water cutout. If the water boils away below a safe level, the starting switch *(S)* will automatically drop to *OFF*, shutting off the current to the heating units. The switch is reset manually but will not stay on (in push in position) until water has been added to entirely cover the heating units and cool them to their normal working temperature.

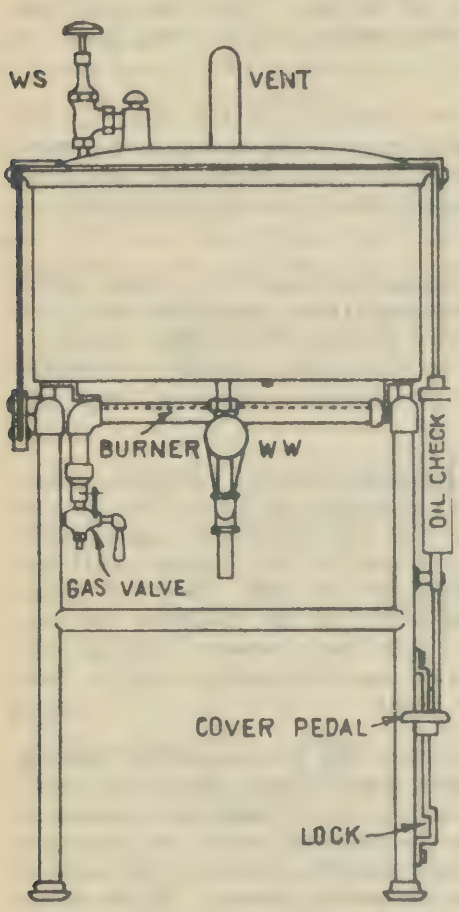
The heating units may be easily cleaned from the inside of the sterilizer after removing the trays.

GAS HEATED INSTRUMENT STERILIZERS
(Non-Pressure Type)

1. Keep all valves tightly closed when sterilizer is not in use. When ready to sterilize, place instruments in the tray and close the cover by releasing the foot lever from the catch at the bottom of the stand. Open the *WATER SUPPLY VALVE (WS)* at the back of the sterilizer (to the left) and fill the sterilizer with sufficient water to cover the tray and instruments when the cover is closed. The use of hot water will materially shorten the time required for heating.

2. Open the gas supply valve (*GS*) under the sterilizer and light the gas burner

with a match or lighter. The air and gas mixing sleeve on the valve should be so adjusted as to give a blue flame. A yellow flame indicates an improper mixture of gas and air.

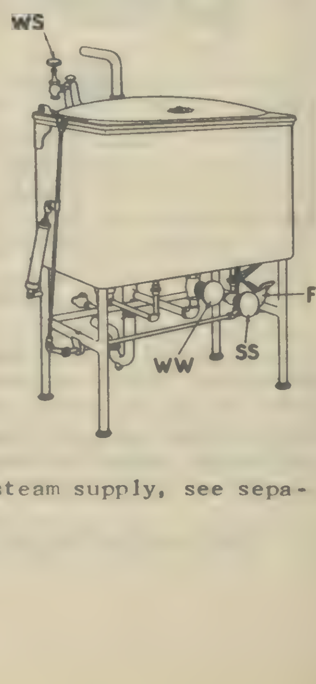


2. After the water starts to boil, *STERILIZE* the instruments in boiling water with the cover closed for not less then 20 minutes. If an excessive amount of waste steam or vapor should escape from under the cover, partially close the gas supply valve to reduce the heat, but still leave the water gently boiling. Violent boiling is unnecessary and a waste of heat. If the sterilizer is equipped with an aspirator for condensing the vapor, see other directions regarding its use. If the sterilizer is equipped with a Vent-O-Stat automatic gas control see directions pertaining to this control.

3. When through sterilizing, close the *GAS SUPPLY VALVE*, raise the cover and tray with the foot lever, allow the instruments to drain for a moment, and then remove the tray from the sterilizer with sterile tray hooks. If sterilizer is to be used again soon, close the cover and leave the gas burning at low heat.

STEAM HEATED UTENSIL STERILIZERS - NON PRESSURE

1. Keep all valves closed when sterilizer is not in use. When ready to sterilize, open the cover by stepping on the foot pedal (F), place utensils in the tray and and close the cover by releasing the foot lever from the catch.



2. Open the valve marked *WATER SUPPLY (WS)*; at the back of the sterilizer (to the left) and fill the sterilizer with sufficient (hot) water to cover the utensils and tray when cover is closed.

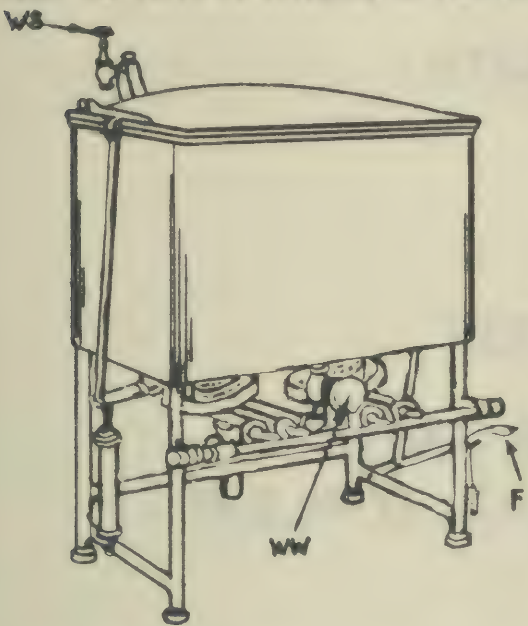
3. Open valve marked *STEAM SUPPLY (SS)*.

4. After water starts to boil, *STERILIZE* the utensils in boiling water with the cover closed for not less than 20 minutes. If steam should escape from under the cover during the sterilization period, partially close the *STEAM SUPPLY VALVE (SS)* until just enough steam is admitted to keep the water gently boiling. Violent boiling is unnecessary and is a waste of heat. If the sterilizer is equipped with an aspirator for condensing the excess steam, or with a Vent-O-Stat for controlling the steam supply, see separate Operating Directions.

5. When through sterilizing, close the *STEAM SUPPLY VALVE (SS)*, raise the cover with the foot lever, raise the tray above the water line, allow the utensils to drain, and then remove from the sterilizer. If the sterilizer is to be used again soon, the *STEAM SUPPLY VALVE (SS)* may be left partially open.

GAS HEATED UTENSIL STERILIZERS
(NON-PRESSURE)

1. Keep all valves closed when sterilizer is not in use. When ready to sterilize, open the cover by stepping on the foot pedal (F), place utensils in the tray and close the cover by releasing the foot lever from the catch.



2. Open the valve marked *WATER SUPPLY (WS)* at the back of the sterilizer (to the left) and fill the sterilizer with sufficient water (*hot*) to cover the utensils and tray when the cover is closed.

3. Light the burners under the sterilizer and open full for maximum heat.

4. After water starts to boil, sterilize the utensils in boiling water with the cover closed for not less than 20 minutes. If steam should escape from under the cover during the sterilization period, partially close the *GAS SUPPLY VALVE* until just enough gas is admitted to keep the water gently boiling. Violent boiling is unnecessary and is a waste of heat. If the sterilizer is equipped with a Vent-O-Stat for controlling the gas supply, see separate Operating Directions.

5. When through sterilizing, close the gas supply valve, raise the cover with the foot lever, raise the tray above the water line, allow the utensils to drain, and then remove from the sterilizer. If the sterilizer is to be used again soon, the *GAS SUPPLY VALVE* may be left partially open.

CHAPTER II

STERILIZERS

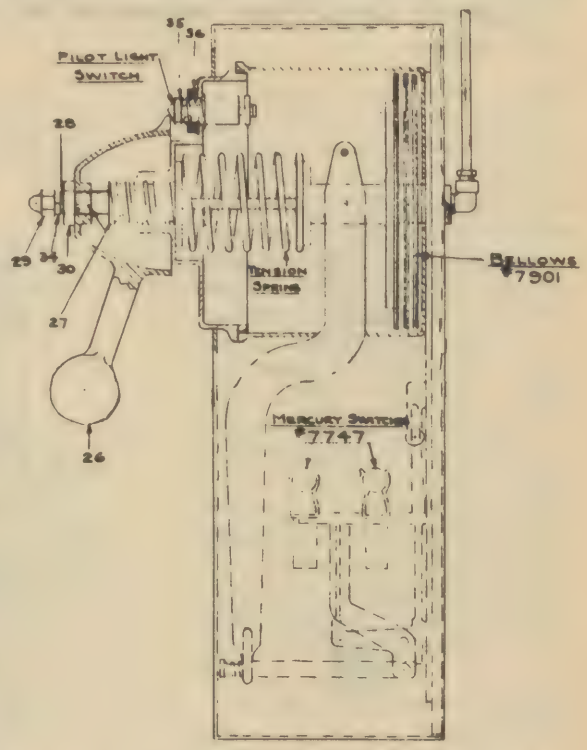
SECTION 18

SPECIAL PARTS SECTION
- WILMOT CASTLE STERILIZER -

INSTRUCTIONS FOR ADJUSTING ELECTRIC PRESSURE CONTROL VALVE HAVING 15-22 LBS. RANGE

"A"

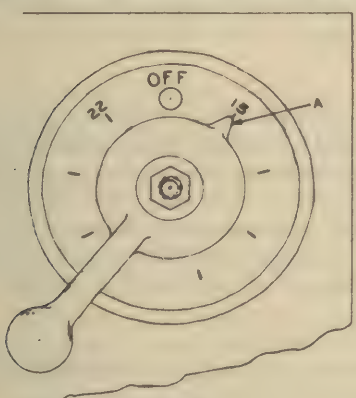
1. Turn handle #26 so that pointer is on "15" mark.
2. Hold nut #34 with wrench and remove lock nut #29.
3. Turn nut #34 so that it just touches the washer on nut #30. Hold adjusting nut #34 in this position and tighten lock nut #29. Turn handle #26 so that pointer is at "Off" position. Then switch, control, and pilot light will be off.



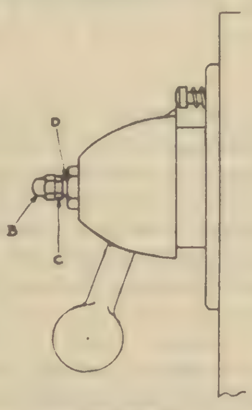
Instruction "A" should cover any ordinary adjustment necessary on this job.

IF, AFTER MAKING ADJUSTMENT "A", PRESSURE RUNS OVER 22 LBS. OR UNDER 15 LBS.

1. Hold nut #34 with wrench and loosen lock nut #29.
2. Remove #29, nut #34, lock nut #30, and handle #26. (Pull handle straight forward.)
3. See that stem #28 is screwed tightly in place.
4. Rotate slotted adjusting nut #27 to the right to turn on the current. Generate pressure in the jacket, then rotate slotted adjusting nut #27 to the right or left until mercury switch cuts off current at 15 lbs. pressure. Rotating #27 to the left lowers the pressure at which the current is borken; rotating #27 which the current is broken. Use care not to mar slotted surfaces of #25.
5. When adjustment is made so that mercury switch breaks current at 15 lbs pressure, replace handle #26 with pointer at "15" mark.
6. Replace nuts #30, #34, and #29 in accordance with Instruction "A"



FRONT VIEW OF CONTROL BOX



SIDE VIEW OF CONTROL BOX

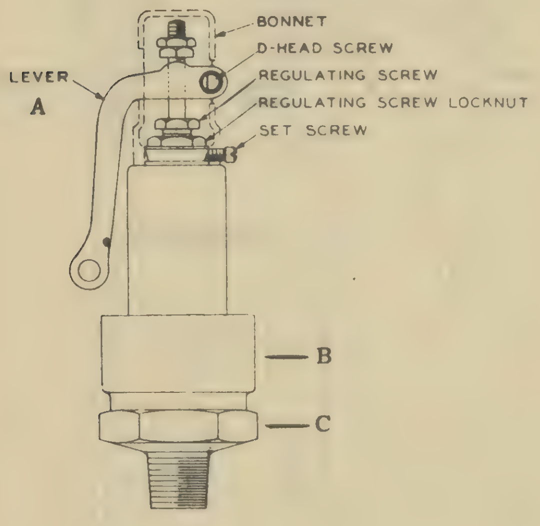
If adjustment "B" has been made it may be necessary to adjust pilot light switch so that the pointer on handle #26 just presses the button in to break the pilot circuit at the "Off" position. To adjust pilot light switch, loosen two set screws #36; slide switch button sleeve in or out as may be necessary; then tighten two set screws #36 to hold the sleeve in position.

NOTE: Before making any adjustment, see that pressure gauges on sterilizer return to Zero when there is no pressure in the jacket or chamber. Pressure gauges may be reset by Zero by turning center screw with screw driver.

WILMOT CASTLE

SAFETY (POP) VALVES - On pressure sterilizers they are for the purpose of releasing excess pressure within the sterilizer. They are safety devices, as the name indicates, and should, therefore, be frequently inspected and tested.

Safety valves should be tested daily by simply raising the lever arm (A) of the valve when there is pressure in the sterilizer to see if steam will escape freely through the valve. When the arm (A) is released, the valve should close promptly and tightly.



The safety valves are set and sealed at 22-25 lbs. pressure in the sterilizer. The setting should not be changed unless checked by means of an accurate steam pressure gauge. If necessary to change the adjustment, proceed as follows:

Remove D-head screw from bonnet. Remove lever. Loosen bonnet set screw and remove bonnet from top of valve.

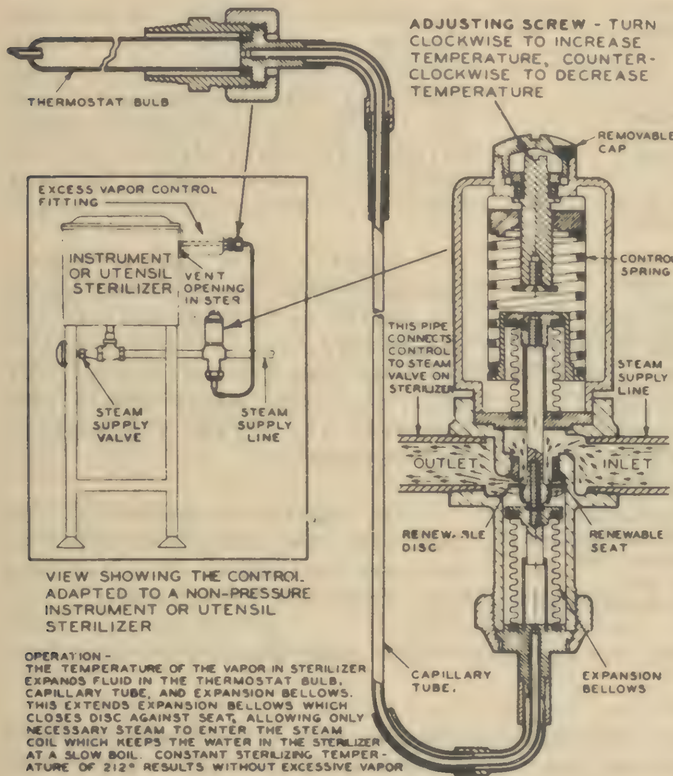
The pressure at which the safety valve releases is determined by the tension of the spring which is adjusted by the regulating screw at the top of the valve. The lock nut is provided to lock the regulating screw in place after the proper adjustment has been made. If the regulating screw cannot be screwed down sufficiently to produce the required pressure, a new spring must be installed. To adjust turn regulating pressure screw UP to reduce set pressure. Turn DOWN to increase set pressure.

If the safety valve leaks steam continuously, the trouble is usually caused by dirt or scale lodging in the valve seat, preventing the valve disc from seating properly. When this occurs, the valve should be removed from the sterilizer, taken apart and carefully cleaned.

DIRECTIONS FOR CLEANING VALVE SEAT - Remove set screw in lower side of valve and unscrew upper shell (B) from lower part (C). Clean the valve disc and valve seat. The gear-like ring nut regulates the differential between the releasing and closing pressures. This differential which should be about two pounds, can be regulated by turning the ring nut to the right or to the left through the opening for the set screw, bringing the nut closer to or farther away from the valve disc. Replace the set screw when properly adjusted, locking the ring nut in its correct position.

If the valve leaks because of a worn seat or disc, they may sometimes be successfully ground in with a find valve grinding compound.

EXCESS VAPOR STEAM CONTROL VALVE, DIRECTIONS FOR CARE AND MAINTENANCE. The excess vapor control is installed on steam heated nonpressure instrument or utensil sterilizers to automatically regulate the flow of high pressure steam to the heating coil according to the need for heat in the sterilizer. The control consists of a packless steam control valve installed on the steam supply line between the steam supply valve and the heating coil, and is operated by the temperature of the exhaust steam as it enters the vent fitting attached to the back of the sterilizer.

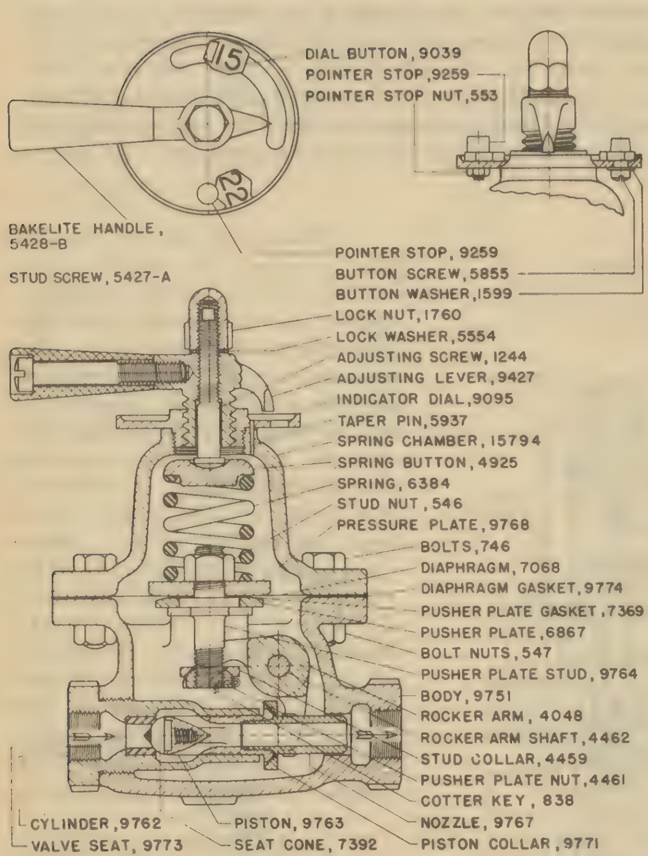


When the water in the sterilizer is below the boiling point the control valve is wide open allowing full supply of steam to the heating coil. As the water in the sterilizer begins to boil, the steam generated in the sterilizer enters the vent fitting, and heats the bulb of the power element installed in it. When properly adjusted, by the time the sterilizer and vent fitting are thoroughly heated, a pressure is created in the bulb which causes the expansion bellows in the control valve to expand, shutting off the supply of steam to the heating coil.

A greater or lesser flow of steam through the valve may be obtained by adjusting the adjusting screw on top of the valve. If the screw is turned clockwise the spring tension will be increased, thus increasing flow of steam through the coil and consequently the temperature of the water, if the screw is turned counter clockwise the reverse will result. With this adjustment just enough steam will be admitted to the coil to keep the water at proper sterilizing temperature without excessive vapor.

When the cover is opened, or fresh water is added, or a load of instruments or utensils are placed in the sterilizer, the temperature of the power element drops, allowing the diaphragm to contract, and the control valve to open to allow full steam supply to the heating coil until boiling is resumed. When properly adjusted, the control valve should open within approximately 30 seconds after the cover is opened or fresh water is added. The valve should close within approximately 30 seconds after the appearance of steam from under the cover.

WILMOT CASTLE STERILIZER



IMPORTANT INSTRUCTIONS - If the Valve is removed from the line for any reason make sure that the direction of flow is right when you put it back in use again. The direction of flow is indicated by the arrow cast on the wall of the body.

If the Valve does not deliver the pressure indicated by the cast figures on the dial remove lock nut atop Valve and turn slotted adjusting screw slowly until you get the delivery pressure which matches the cast figure on the dial; the one to which you are pointing the adjusting lever.

Erratic Valve action usually indicates that the internal parts are fouled by foreign matter. To clean them, you unscrew the cylinder from the valve body. All the inner valve parts should come out with it. Clean thoroughly, and reassemble.

If the Valve should fail to shut off, the valve seat and cone may need regrinding; or after long use, complete replacement.

The Valve Seat is pressed into the cylinder. The Seat Cone is screwed into the piston.

To replace diaphragms, remove the spring chamber and slip diaphragmsaand pressure plate toward the inlet side of the valve, to disconnect from rocker arm. Diaphragms can then be replaced — simply by removing the nut atop the pressure plate.

CAUTION: Do not molest the cotter-keyed nut on the lower end of the pusher plate stud. This adjustment is fixed at the factory.

In replacing diaphragms, be sure that the pusher plate collar is hooked under the rocker arm. Of course, a new pusher plate gasket should be used at such a time.

CASTLE AUTOCLAVE DIRECT STEAM HEAT PRESSURE AND REGULATING VALVE

PURPOSE OF VALVE - The purpose of this valve is to reduce and regulate the flow of steam from the boiler to the autoclave, so that a predetermined pressure may be maintained in the autoclave without manual control of the steam valve. Working range 15#-22#.

METHOD OF OPERATION

1. Valve is normally open.

2. Diagram on reverse side shown valve in closed position.

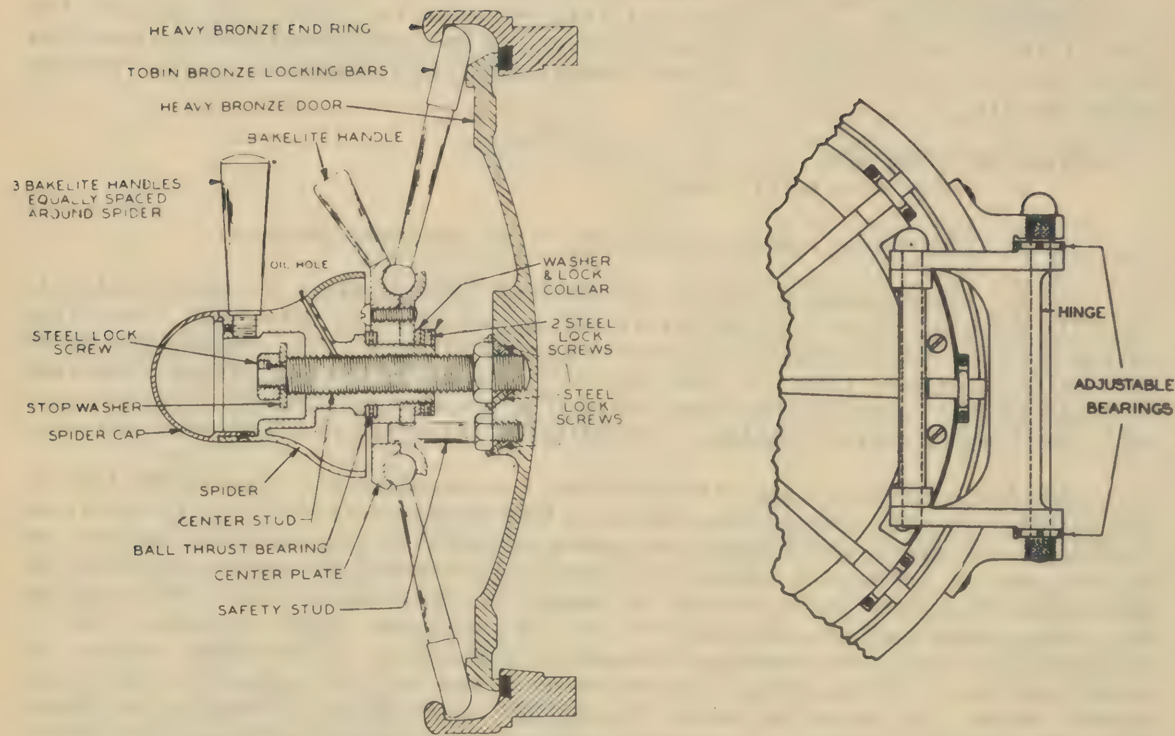
3. Steam enters valve as indicated by arrow, passes by piston which is normally open and flows through nozzle and out of valve to autoclave. Note that nozzle projects out of chamber into outlet in body of valve. The purpose of this is to develop an ejector effect so that when valve is opened during operation the rush of steam tends to suck any remaining steam from the chamber of valve, thus assuring more rapid and efficient action by immediately relieving pressure on diaphragm.

When the inrushing steam passes through the autoclave and reaches the trap on the return line, the trap closes causing a back pressure to build up in the steam chamber of the valve. This exerts an upward pressure on the diaphragm against the spring tension. When the pressure in the steam chamber of valve overcomes the spring tension (which is adjustable) it causes the diaphragm to raise, thus causing the pusher plate assembly to rise with it. As the pusher plate assembly rises it actuates the rocker arm causing pressure on the piston collar which closes the piston and shuts off the steam. As the steam is shut off the pressure in the valve chamber drops. The adjusting spring forces down the diaphragm releasing the rocker arm. The incoming steam is then able to force open the piston and pass on again into the autoclave—this process is repeated all during the operating period.

By removing the adjusting lever clockwise or counterclockwise, the tension on adjusting spring may be increased or decreased, thus enabling the operator to set the valve for any desired pressure between 15 and 22 pounds.

TO ADJUST VALVE - Remove lock nut and lock nut washer, turn adjusting lever clockwise to increase pressure; counterclockwise to decrease pressure. Replace lock washer and lock nut and tighten.

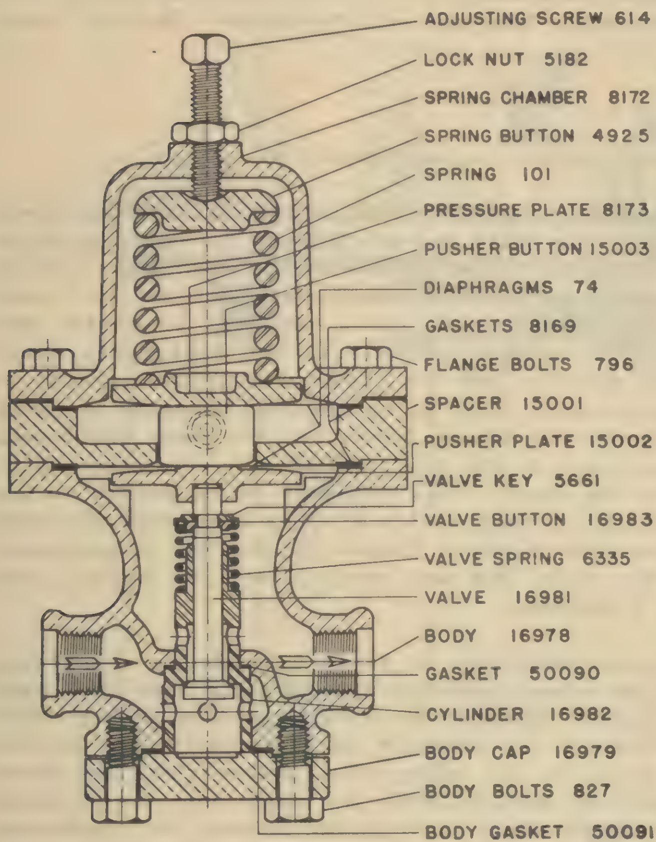
To adjust to working range (15-22 lbs.) proceed as follows: Turn adjusting lever to 22# stop, remove lock nut and lock washer, turn adjusting screw until 22# registers on chamber gauge. Replace and tighten lock nut and lock washer. Loosen Dial button 15 and slide back in slot. Release some pressure from chamber (to below 15#), turn back adjusting lever until 15# registers on chamber gauge. Then return Dial button 15 so that stop bears against pointer of adjusting lever. Fasten Dial button.



ADJUSTMENT OF DOOR ON CASTLE AUTOCLAVE

Should the door tend to sag because of wear after a long period of use, this may be compensated for by the adjustable bearings indicated in accompanying diagram. It will be noted that there are holes drilled at regular intervals around the periphery of the bushings. By inserting a suitable size tool in the most convenient hole, the bushings may be turned in either direction to realign the door. Before attempting to turn bushings, first of all loosen set screws. Tighten these set screws after adjustment is made.

IMPORTANT INSTRUCTIONS - If you take this Valve off the line for any reason; make sure that the direction of flow is right when you put it back in use again. (An arrow is cast on the body of the Valve to indicate the direction of flow.)



If there is any need to adjust this valve for a higher (or lower) pressure in the Sterilizer, all you do is loosen lock nut 5182, and gradually turn adjusting screw 614. To INCREASE pressure in the Sterilizer turn the adjusting screw clock-wise. To DECREASE pressure in Sterilizer turn adjusting screw counter clock-wise.

Any erratic Valve action usually is caused by foreign matter that fouls the inner valve. Remove body bolts 827; take off body cap. Then inner valve parts should come out like a cartridge. Clean thoroughly. When you reassemble Valve; use new gaskets 50090 and 50091 (not home made ones, for thickness must be right). Also be sure you center valve 16981 in the recess of pusher plate 15002.

If the Valve should fail to shut off, it may be due only to some foreign substance on the seat hence correctible by cleaning. If the valve seats show slight injury, they may need regrinding. If worn, after long use, better replace them, getting the complete inner-valve cartridge unit.

Should it become necessary to replace the upper set of diaphragms; first back off lock nut 5182, and unscrew adjusting screw 614, to take all the tension off of spring 101. Then remove spring chamber 8172.

Caution: Only *one* gasket is used with the upper set of diaphragms. It is located below the diaphragms, as shown in cut on opposite page.

To replace the lower set of diaphragms; first take off spring chamber as described above, then also remove spacer 15001. Two gaskets are used -- *one* above diaphragm, and *one* below diaphragm. It is always best to replace these gaskets, when installing new diaphragms. Important: Never use more diaphragms than you find installed in the Valve originally.

CASTLE WATER STERILIZER STEAM HEAT PRESSURE AND REGULATING VALVE

PURPOSE OF VALVE - The purpose of this valve is to regulate the flow of steam to the steam coils so that any specified pressure (or temperature) may be maintained in the water sterilizer during the sterilizing process. The use of a reducing and regulating valve such as this eliminates manual control of the operating valves and assures that the proper temperature is automatically maintained. It also aleviates the annoyance of constantly "popping" safety valves. Working range from 15# to 22#.

1. Valve is normally open.

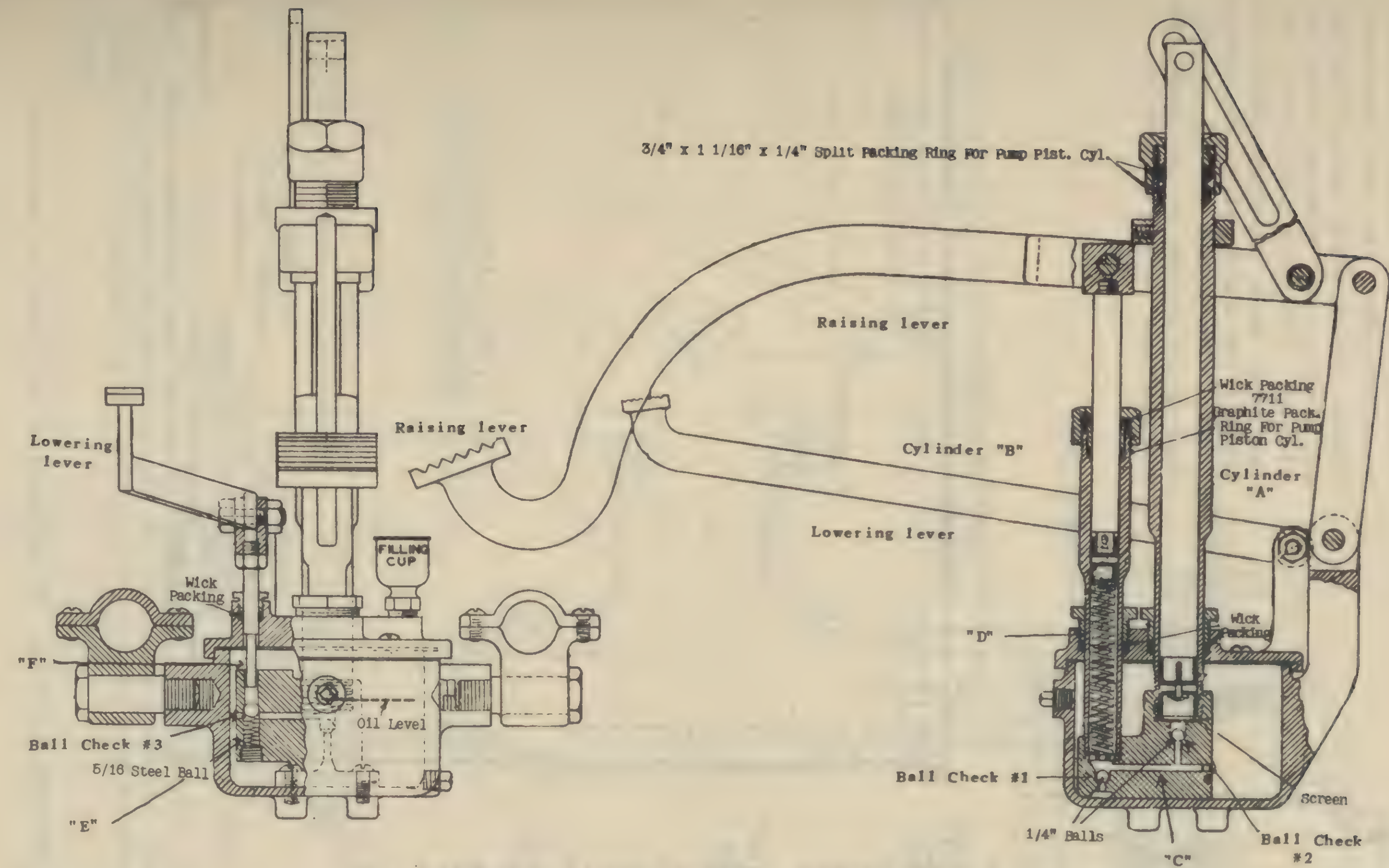
2. Diagram on reverse side shows valve in closed position.

3. Steam enters valve as indicated by arrow on diagram, passes through lower ports of cylinder, continues on up past the valve and out through the upper ports of the cylinder, and so on out to the steam coil. It is to be noted that the steam in the valve body exerts only a comparatively small upward pressure on the lower diaphragm even when the trap on the other end of the steam coil is closed and consequent back pressure results. The reason for this is the relatively small working area of the lower diaphragm, and the fact that the heave tension spring in the spring chamber counteracts what pressure there is by exerting downward pressure on both the upper diaphragm and through the spacer block on the lower diaphragm, thus holding the valve open. As the water in the tank is heated by the steam coil, pressure will start to build up in the tank. This pressure is conducted to the sealed space between the two diaphragms by means of a ¼" pipe connected directly from the inside of the tank to the sealed space formed by the two diaphragms. Therefore whatever the pressure in the tank, the same pressure will be found in the space between the upper and lower diaphragms.

4. As the pressure in this space increases it tends to push the diaphragms apart. Since the upper diaphragm has a much greater working area than the lower diaphragms the upper diaphragm will push against the heavy adjusting spring until it overcomes the spring tension relieving the pressure on the lower diaphragm and hence permitting the valve spring to close the valve, thus shutting off the steam supply. Naturally as the steam supply is shut off from the steam coil the pressure in the tank drops, and consequently the pressure in the space between the diaphragms drops allowing the adjusting spring to push the diaphragms down and open the valve, again admitting steam to the steam coils. This process is repeated until the sterilization period is completed.

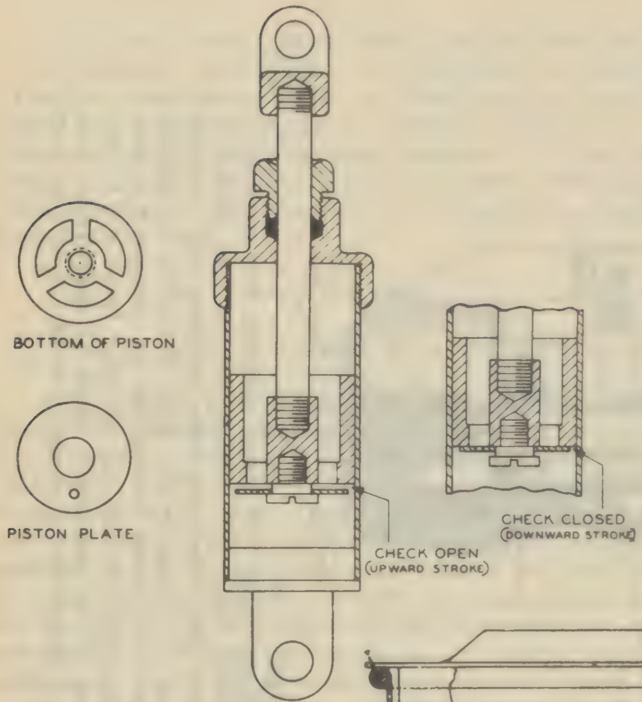
It may be asked why two diaphragms are used. The answer is simple. The medium conducting the tank pressure to the space between the diaphragms will of course be water since the tanks are filled with water. On a simple diaphragm type valve using the same principle, ie. the use of tank pressure in the valve chamber to operate the diaphragm, it was found that when the valve was worn considerably, the chamber would begin to leak and permit water from the tank to escape to the return and thus empty the tank.

ADJUSTMENT - To adjust this valve loosen the lock nut on the adjusting screw. If it is desired to increase the pressure in the tank turn the adjusting screw clockwise thus increasing the tension of the large adjusting spring until the desired pressure is reached. To lower the pressure in the tank turn adjusting screw counterclockwise, thus loosening the tension on the large adjusting spring. Tighten lock nut when desired pressure is reached.



OIL LIFT FOR LARGE UTENSIL STERILIZER

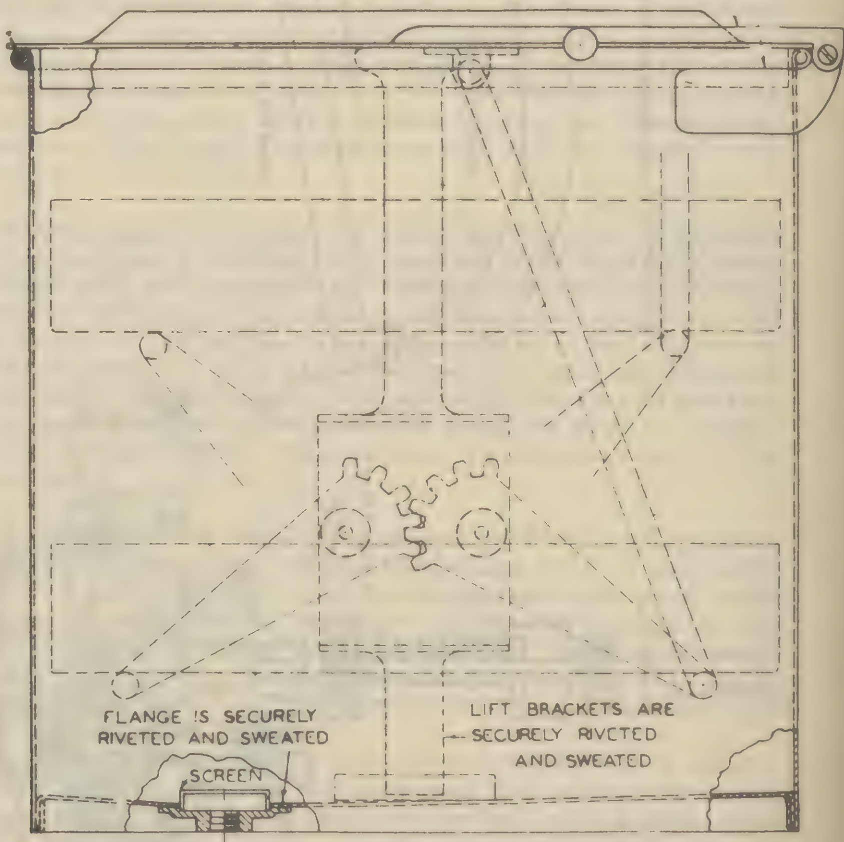
"Raising lever" is kept at top of upward stroke by spring "D" in cylinder "B" thus causing the piston in cylinder "B" to draw oil into this cylinder from the reservoir past Ball Check #1. When the raising lever is forced down, piston in cylinder "B" forces oil through passage "C" and past Ball Check #2 into cylinder "A" causing piston in cylinder "A" to rise and thus lift lid. On the down stroke of "raising lever" Ball Check #1 is seated and Ball Check #2 is forced open to permit passage of oil into cylinder "A". Upon completion of downward stroke Ball Check #2 is seated thus retaining oil in cylinder "A", about 4 downward strokes on raising lever will completely raise lid. To lower lid depressing lowering lever will cause pin "F" to push Ball Check #3 away from seat and thus allow oil to escape from cylinder "A", back into reservoir. Ball Check #3 is normally held closed by coil spring "E".

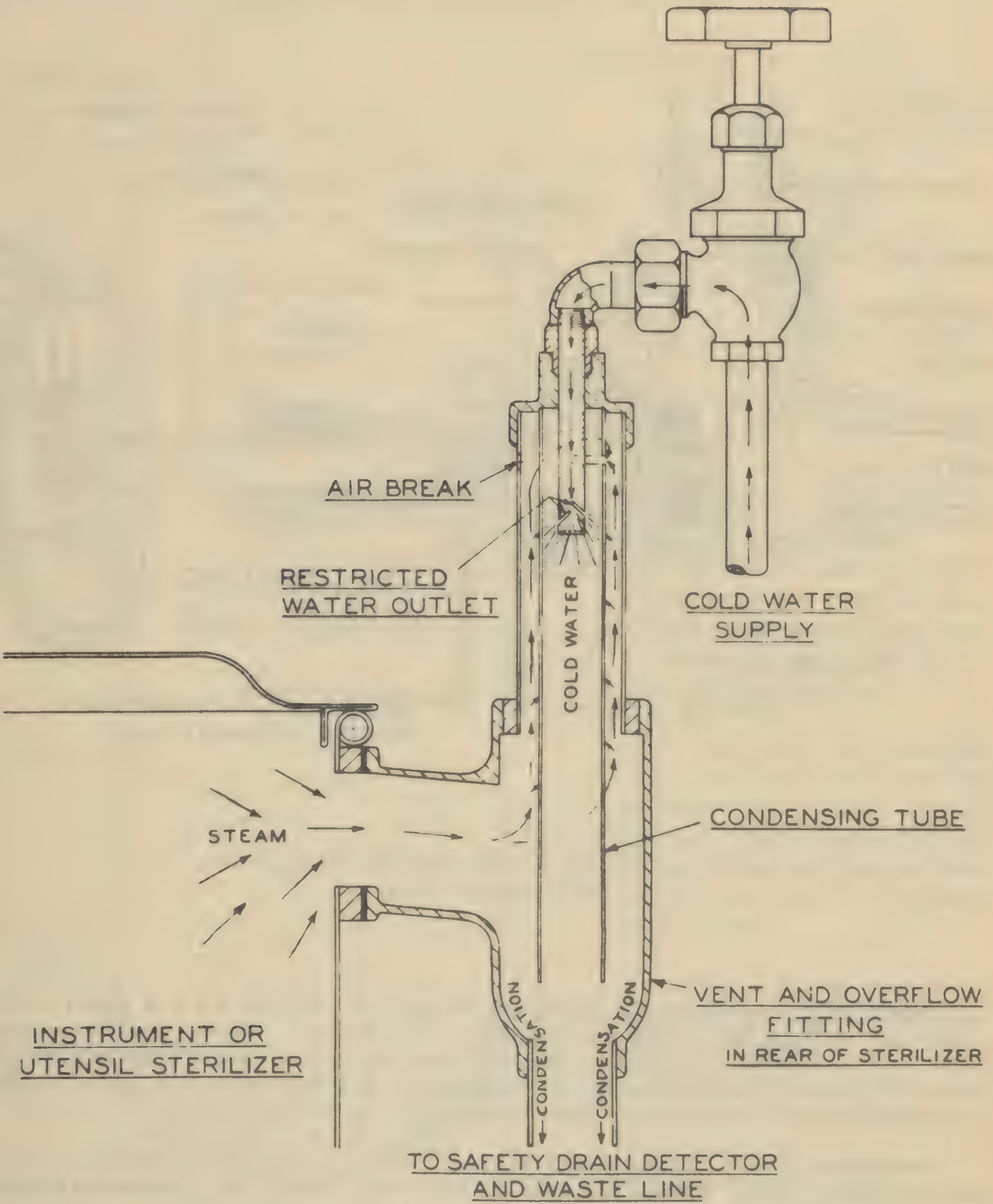


OIL CHECK FOR INSTRUMENT STERILIZER - This check prevents lid of sterilizer descending too rapidly. On upward stroke piston plate drops from bottom of piston and allows oil to flow rapidly through holes in piston. On downward stroke, the oil pressure forces piston plate against bottom of piston thus closing holes in piston. The only place that oil can then pass through piston is through the small hole in the piston plate. The speed the piston can descend is limited by the speed the oil can pass through this hole.

Non-pressure Utensil and Instrument Sterilizers

Tray raising and lowering mechanism.

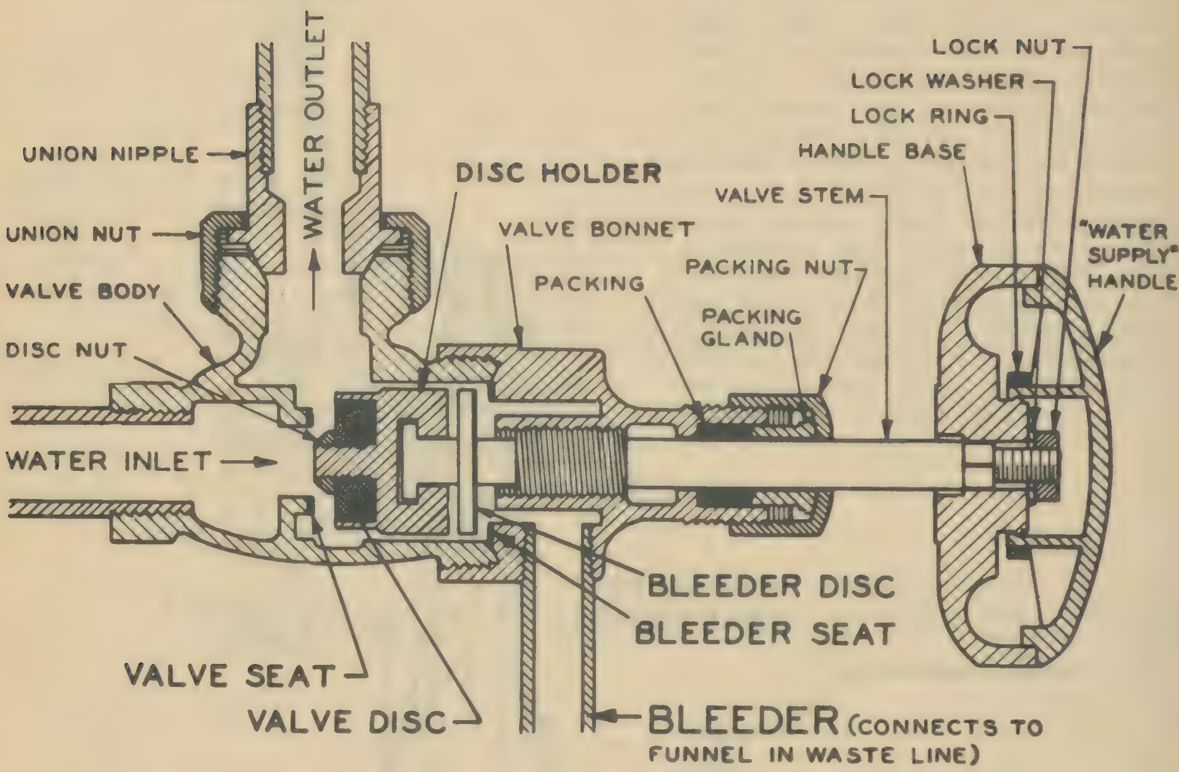




CASTLE CONDENSER VENT VALVE
SECTION SHOWING PROTECTIVE FEATURES

This condenser vent is used to create a slight vacuum inside the sterilizer and thus withdraw the vapor caused by the boiling water. The cold water passing through the condenser vent, condenses this vapor and discharges it to the waste line.

A condenser of this type eliminates the use of an atmospheric vent.



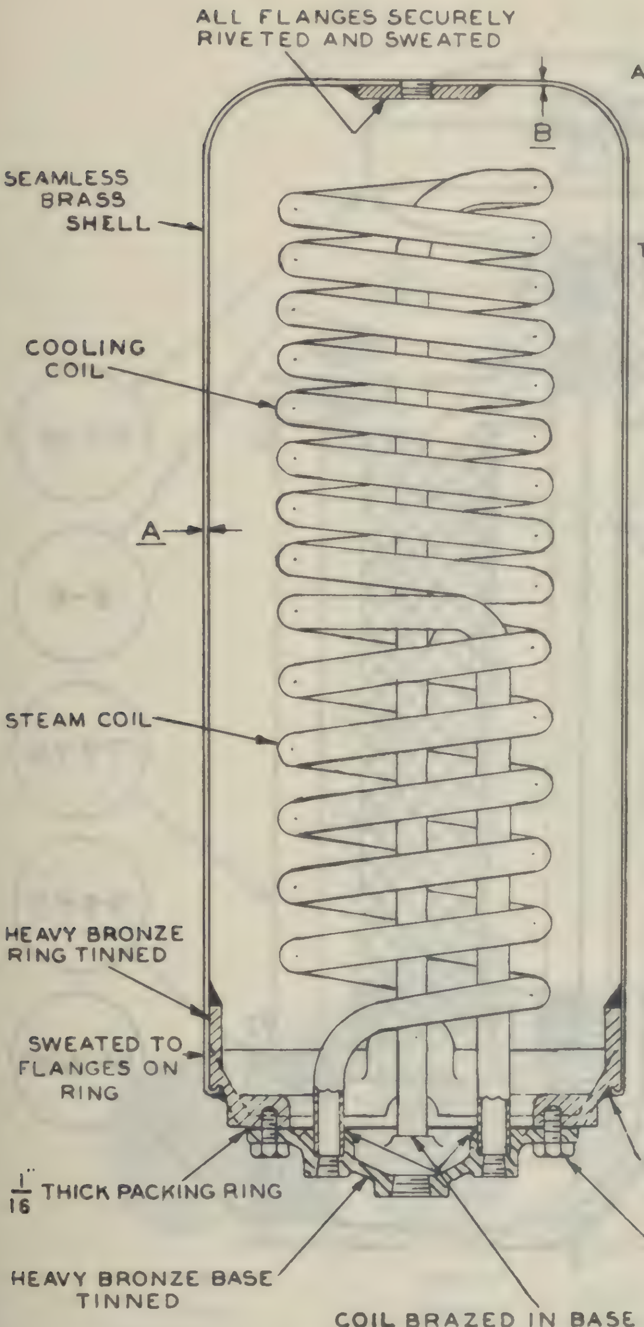
CASTLE WATER SUPPLY VALVE
WITH SAFETY BLEEDER

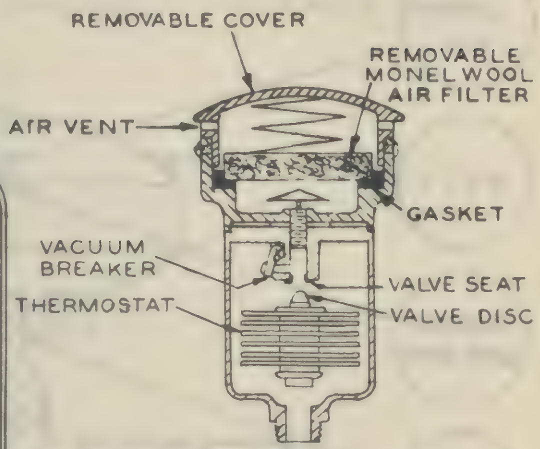
PURPOSE - This valve is designed to prevent leakage of raw water reaching a sterile tank on Water and non-pressure Sterilizers. Should the Valve Disc or Valve Seat become worn; not seat properly, or the valve not be tightly closed, raw water will pass thru the Bleeder to the drain. The Bleeder has a leakage capacity of approximately 30 gallons per hour depending on water pressure.

OPERATION - When closed, Valve Disc closes against Valve Seat and Bleeder remains open. When valve is opened to the *full reach*, the Bleeder Disc closes against the Bleeder Seat and the Bleeder is closed. Unless valve is opened to the *full reach*, water will leak thru Bleeder and cause slow filling.

SERVICING - The Packing Nut should be drawn up gradually on all valves when new, until broken in, to prevent leakage thru Packing Nut. Foreign substance holding valve open can generally be loosened by quickly opening and closing valve. If this fails to remove obstacle, unscrew Valve Bonnet and clean Valve Seat and Disc. New Jenkins No. 80 valve disc can be replaced when worn. One or two extra disc holders with Valve Disc inserted should be kept in stock to facilitate quick replacement permitting spare Disc Holders to be packed at leisure.

INTERIOR VIEW WATER STERILIZER TANK



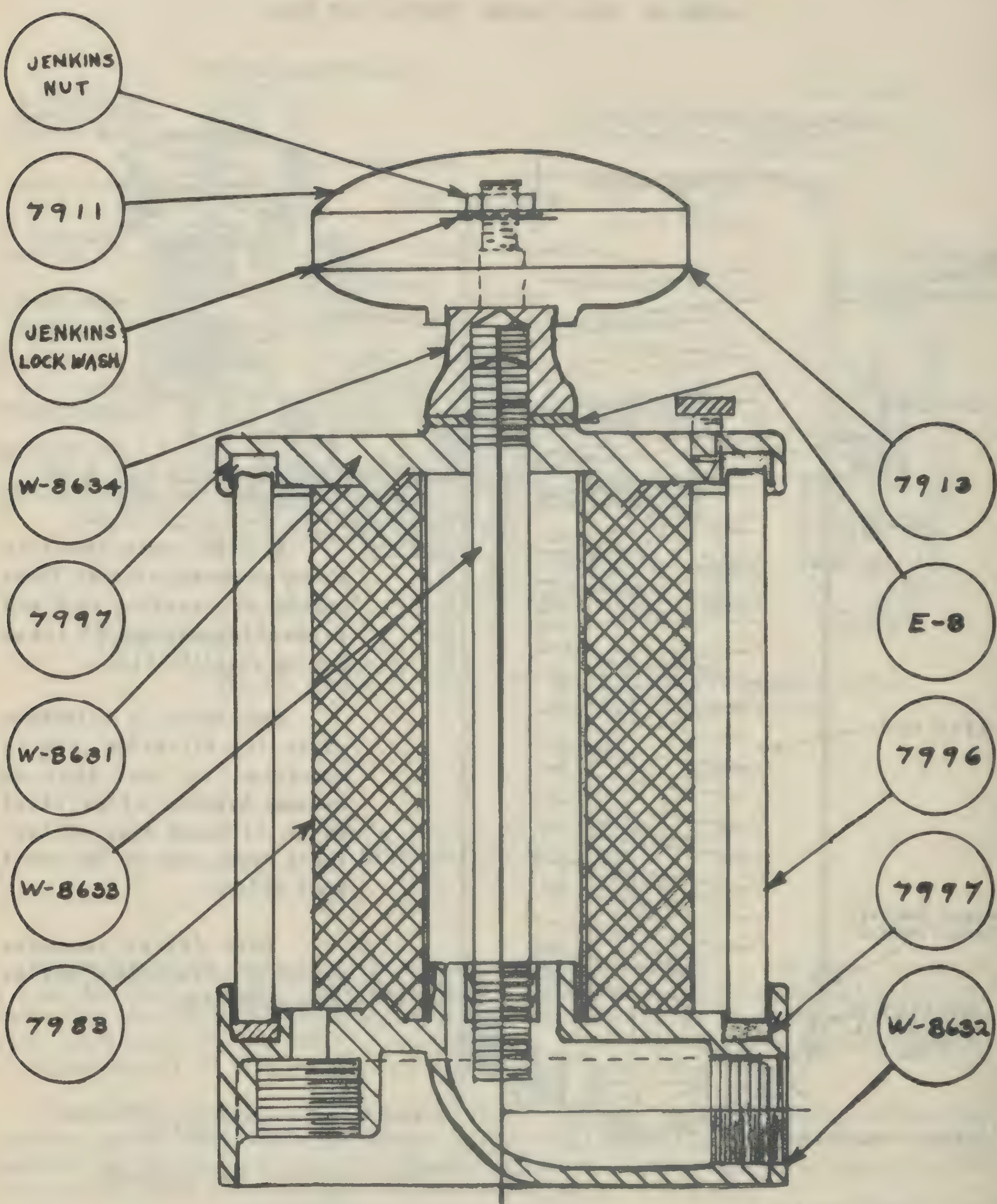


AUTOMATIC AIR RELEASE AND AIR INTAKE VALVE

As water comes to a boil steam ascending strikes thermostat thus sealing tank and preventing escape of steam during sterilization.

When water is withdrawn after sterilization, air is admitted to tank through vacuum breaker after first being filtered free of bacteria laden dust by the monel wool filter.

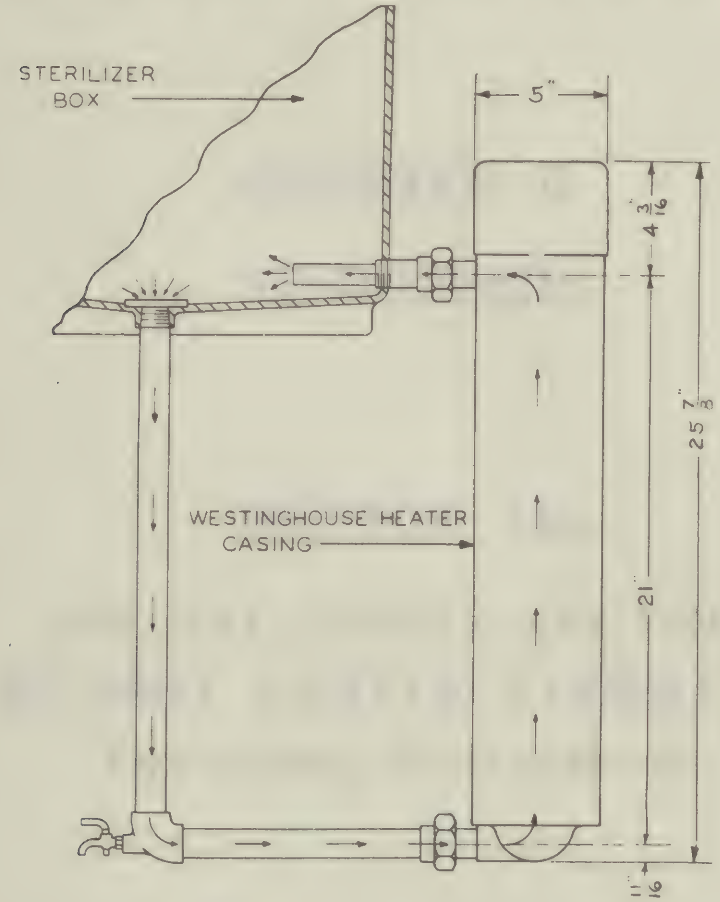
This filter is automatically sterilized during each operation.

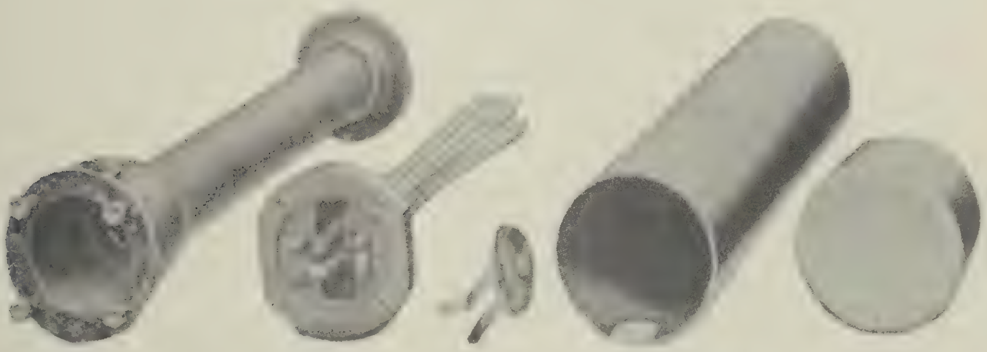


WATER FILTER ASSEMBLY

The filtering units are "Fulflo" cotton fibre, visible through glass casing, when filters become dirty, discard and replace with new filters. Filters are replaced by unscrewing hand wheels and lifting out filters. Make sure gaskets #7997 are in good shape, if not replace same.

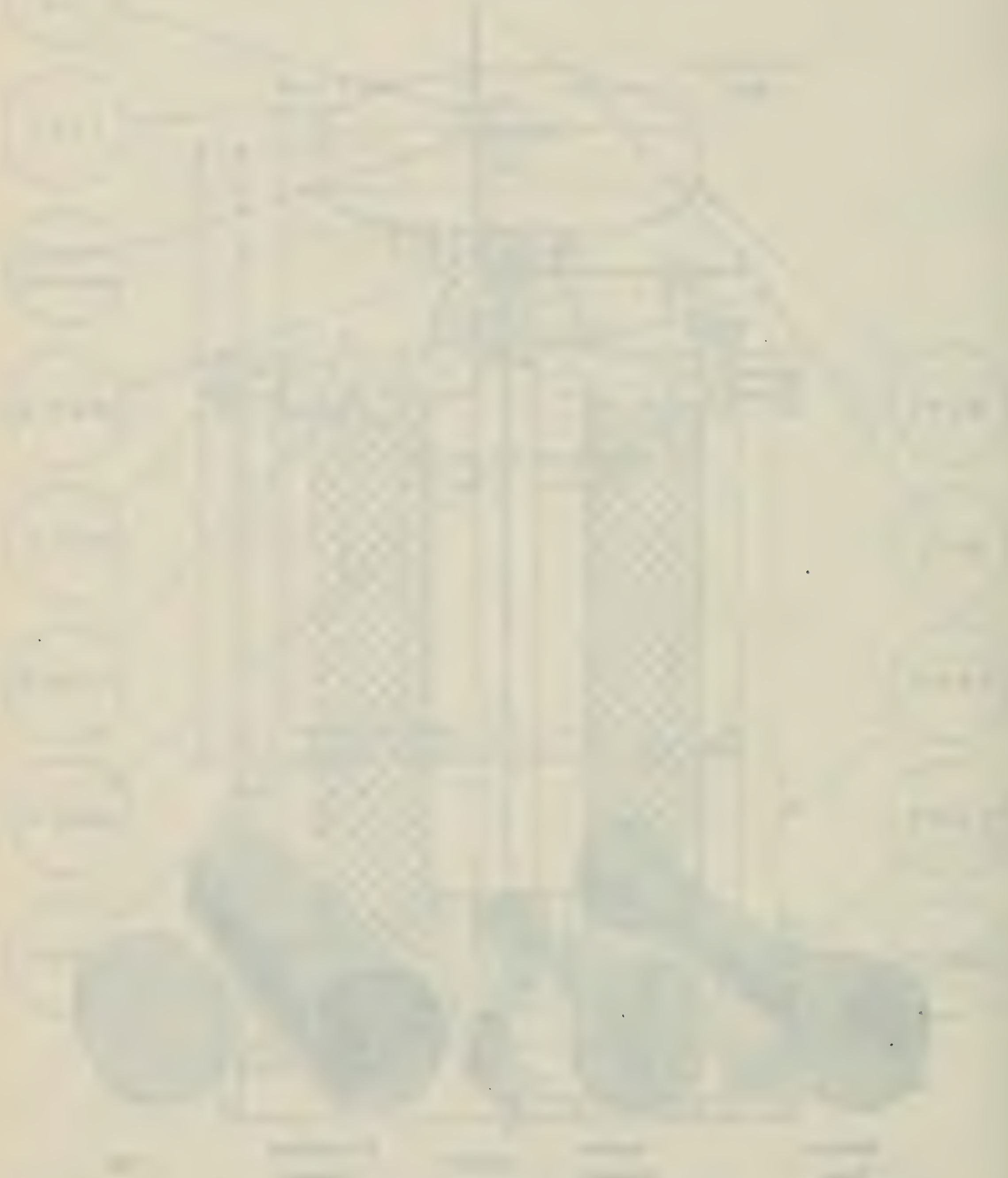
APPLICATION OF ELECTRIC HEATERS TO STERILIZERS
SECTION THRU STERILIZER BOX SHOWING WATER CONNECTIONS THRU WESTINGHOUSE HEATER AND DIRECTION OF CIRCULATION





Heater Case | Heater Element | Cutoff | Finishing Jacket | Cap

The same type and capacity (3500 Watts) heating units are used on all Castle hospital sterilizers. Therefore, provided the voltage corresponds, all these heaters are interchangeable. For instance, if an Instrument Sterilizer heating unit failed, one could borrow a heating unit from another sterilizer (generally a Water Sterilizer, since one can always get along with one tank in an emergency) until a replacement heater for the Instrument Sterilizer could be secured. It takes only about thirty minutes to effect the exchange.



CHAPTER II

STERILIZERS

SECTION 18a

SPECIAL PARTS SECTION
- WILMOT CASTLE STERILIZER -
Operating Instructions

SPECIAL PARTS SECTION
WILMOT CASTLE
OPERATING DIRECTIONS
EMERGENCY and PRESSURE INSTRUMENT STERILIZER
DIRECT STEAM HEAT

1. See that all valves are closed.

2. Open "Steam Supply Valve" full.

3. Place instruments in Sterilizer then securely close door. When "Jacket" Pressure Gauge indicates 27 lbs. open "Steam Valve to Chamber". (Air and condensation is automatically discharged. The ejector will at first discharge freely then close gradually as the air is discharged and is replaced by steam at a higher temperature.)

4. When Sterogage Thermometer reaches 270° begin to time the sterilizing period. (For one or two instruments 3 minutes. For tray full of instruments 7 minutes.)

5. After sterilizing period close "Steam Valve to Chamber".

6. Open "Vent Valve". (Never open "Vent Valve" before closing "Steam Valve to Chamber" otherwise undue condensation will result.)

7. When "Chamber" Gauge has returned to zero open door just enough to permit vapor to escape, then, if necessary, allow about one minute drying period.

See that Sterilizer drains freely to discharge opening at front of chamber and is slightly tilted forward by adjusting the feet of the stand.

Steam Regulator Valve is adjusted to maintain 27 lbs. pressure, 270° F. Safety Valve is set at 30 lbs.

IMPORTANT: Raise Safety Valve Lever twice a week to ensure free movement.

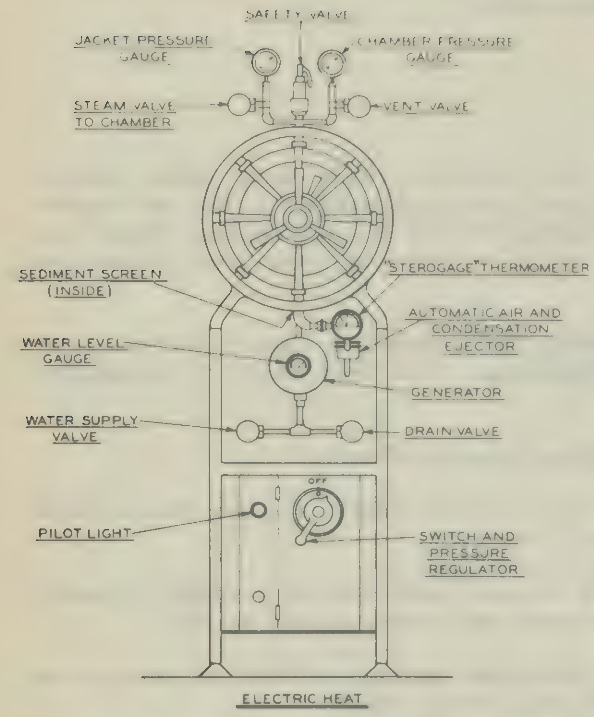
CASTLE DRESSING STERILIZER
ELECTRIC HEAT

1. See that *all* Valves are closed.

2. Open Water Supply Valve to fill Generator.
   a. *With Water Level Gauge* - Close Water Valve when Indicator reads "FULL". If Generator is over filled, drain until indicator holds at "FULL" - not beyond. Then close Drain Valve.
   b. *With Gauge Glass* - (for shipboard use and other special applications.) Fill Generator to within half an inch of top of Gauge Glass. Then close Water Supply Valve. If Generator is over filled, drain until correct level is reached. Then close Drain Valve.

3. Turn switch on Pressure Regulator to pressure at which the Sterilizer is to be operated, 15 to 22 pounds.

4. Load Sterilizer while steam in "Jacket" is being generated. Then close door by throwing over center plate until safety stud is securely engaged. Draw up outer handles of door, tightly but not forcibly, so that it remains steam tight. When "Jacket" Pressure Gauge reaches the pressure at which the Regulator is set, open Steam Valve to "Chamber" gradually. (All air and condensation will escape automatically from "Chamber" through steam trap. If you fail to see or hear the air escape in the form of vapor, clean pin trap or sediment screen at discharge opening, and clean steam trap.)



5. When Sterogage reaches 250° F. (15 pounds in chamber), start to time the sterilizing period. (Sterogage indicates minimum temperature inside the "Chamber". If Sterogage does not register in the Sterile Zone, but remains in the Unsterile Zone, this indicates that the air discharge line is clogged or the air ejector is not functioning and these should be cleaned to eject all air and condensation. Clean strainer in bottom front of Sterilizer daily.)

Flat packs should rest on edge. Arrange goods so that there are free spaces between packs for penetration of steam. Do not pack bundles against door or rear end.

6. After sterilizing period, close Steam Valve to "Chamber".

7. FOR DRESSINGS AND DRY GOODS: Open Vent Valve (*after* Steam Valve to "Chamber" is closed.)

8. When "Chamber" Gauge has returned to zero, open door 1/2" or just enough to permit vapor to escape, from five to ten minutes, leaving steam on "Jacket". If directions have been followed sterile goods will be dry enough for immediate use or storage.

9. Turn switch to "OFF" position when through sterilizing.

10. FOR SOLUTIONS AND LIQUIDS - After closing Steam Valve to "Chamber" (at end of period), turn switch to "OFF" position and allow Vent Valve to remain closed, permitting Sterilizer to cool until "Chamber" Gauge returns to zero.

11. Drain water from Generator daily to remove sediment, while there is still a little pressure in Generator.

12. *CAUTION:* Be sure there is plenty of water in Generator when heat is turned on. Heating Element, Casing and Pipe Connections must be kept clean and free from scale to ensure maximum heating and circulation. Remove heater element from casing for cleaning. How often this will be necessary will depend on local water conditions.

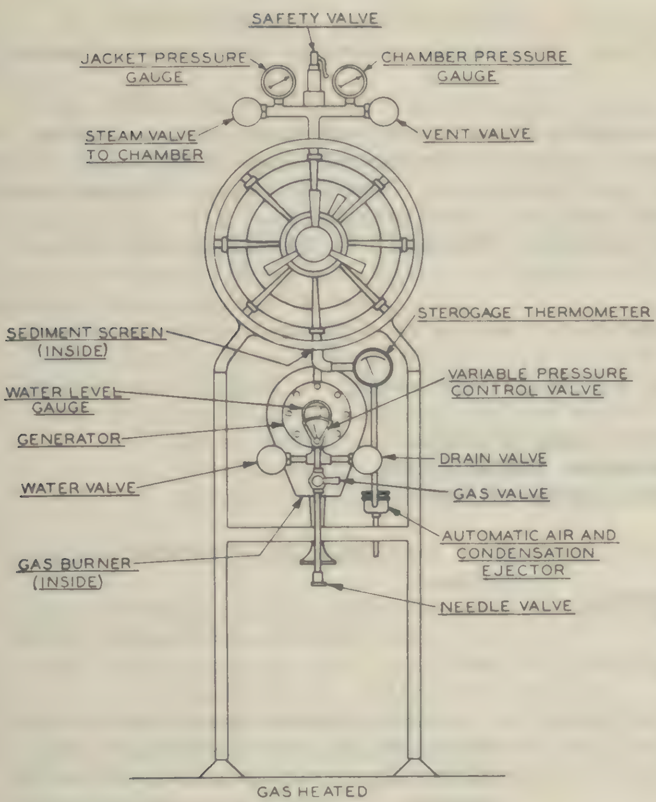
13. Wet dressings will result in *any* Autoclave if -

a. Generator is filled too full, or
b. Steam Valve to "Chamber" is opened too suddenly, or
c. Vent Valve is opened before Steam Valve to "Chamber" is closed, or
d. Air and Condensation Ejector is out of order.

14. *IMPORTANT:* Raise Safety Valve lever twice a week to ensure free movement.

15. If door gasket leaks steam, do not force hand wheel - install new gasket.

CASTLE DRESSING STERILIZER
GAS HEAT



1. See that *all* Valves are closed.

2. Open Water Valve to fill Generator. Close Water Valve when Indicator reads "FULL". If Generator is overfilled, drain to above point and then close Drain Valve.

3. Turn Variable Pressure Control Valve to pressure at which Sterilizer is to be operated. Light gas burner by opening gas valve. (Be sure pilot light is lit.) Temperature and pressure will then be held automatically.

4. Load Sterilizer while steam is being generated, then close door tightly, but not forcibly. When Jacket Pressure Gauge reaches the pressure at which the Regulator is set, open Steam Valve to chamber gradually. (All air and condensation will escape automatically. If you fail to hear the air escape, it will be necessary to clean pin trap, sediment screen and ejector.)

5. When Sterogage reaches 250° F. (15 pounds in chamber), start to time. (Sterogage indicates the temperature maintained inside the chamber. If Sterogage does not register in the Sterile Zone, but remains in the Unsterile Zone, this indicates that the air discharge line is clogged or the air ejector is not functioning and these should be cleaned to eject all air and condensation. Clean strainer in bottom front of Sterilizer daily.)

Flat packs should rest on edge. Arrange goods so that there are free spaces between packs for circulation of steam. Do not pack against door or rear end.

6. After sterilizing period, close Steam Valve to Chamber.

7. FOR DRESSINGS AND DRY GOODS - Open Vent Valve (*after* Steam Valve to Chamber is closed.)

8. When Chamber Gauge has returned to zero, open door 1/2" or just enough to permit vapor to escape, from five to ten minutes, leaving steam on jacket. If directions have been followed sterile goods will be dry enough for immediate use or storage.

9. FOR SOLUTIONS AND LIQUIDS - After closing Steam Valve to Chamber (at end of period) allow Vent Valve to remain closed and Sterilizer to cool until Chamber Gauge returns to zero.

10. Turn off Gas Valve when through sterilizing.

11. Drain water from Generator daily to remove sediment, while there is still a little pressure in Generator.

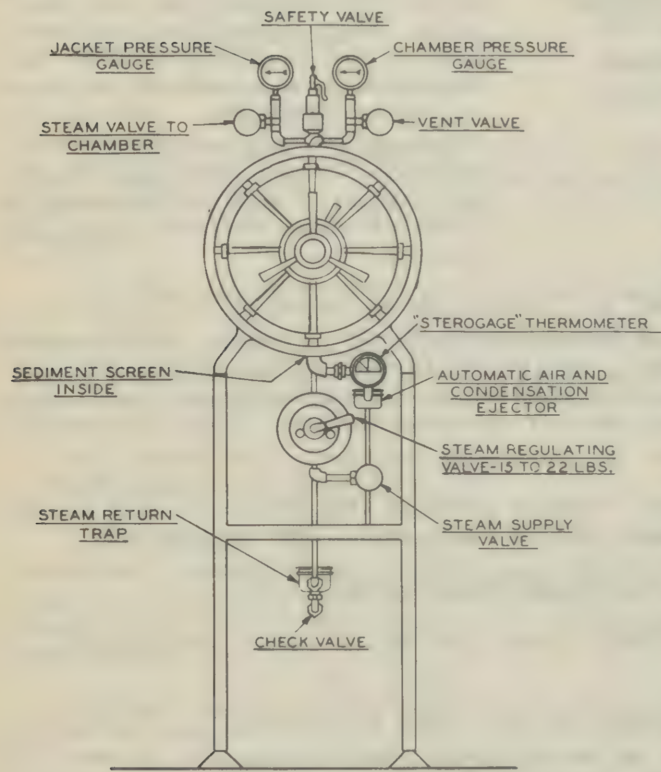
12. *CAUTION:* Be sure there is plenty of water in generator when gas is turned on.

Inside of Generator and stem on Variable Pressure Control Valve and connection, must be kept clean and free from scale to assure maximum heating efficiency. To clean these parts: Release pressure and drain water from Generator. Remove hex cap screws on Generator head. Remove head and clean internally. Also clean stem on Variable Pressure Control Valve. How often this will be necessary will depend on local water conditions.

13. *IMPORTANT:* Raise Safety Valve lever twice a week to insure free movement.

14. If door gasket leaks steam do not force hand wheel - - install new gasket.

OPERATING DIRECTIONS
CASTLE DRESSING STERILIZER
DIRECT STEAM HEAT



STEAM HEAT

1. See that *all* Valves are closed.

2. Open Steam Supply Valve full.

3. Turn Steam Regulating Valve to pressure at which Sterilizer is to be operated, 15 to 22 pounds. (Temperature and pressure will then be held automatically.)

4. Load Sterilizer, then close door tightly but not forcibly. When Jacket Pressure Gauge reaches the pressure at which the regulator is set, open Steam Valve to chamber gradually. (All air and condensation will escape automatically. If you fail to hear the air escape, it will be necessary to clean pin trap, sediment screen and ejector.)

5. When Sterogage reaches 250° F. (15 pounds in chamber), start to time. (Sterogage indicates the temperature maintained inside the chamber. If Sterogage does not register in the Sterile Zone, but remains in the Unsterile Zone, this indicates that the air discharge line is clogged or the air ejector is not functioning and these should be cleaned to eject all air and condensation. Clean strainer in bottom front of Sterilizer daily.)

Flat packs should rest on edge. Arrange goods so that there are free spaces between packs for circulation of steam. Do not pack against door or rear end.

6. After sterilizing period, close Steam Valve to Chamber.

7. FOR DRESSINGS AND DRY GOODS - Open Vent Valve (*after* Steam Valve to Chamber is closed.)

8. When Chamber Gauge has returned to zero, open door 1/2", or just enough to permit vapor to escape, from five to ten minutes, leaving steam on jacket. If directions have been followed sterile goods will be dry enough for immediate use or storage.

9. FOR SOLUTIONS AND LIQUIDS - After closing Steam Valve to Chamber (at end of period) allow Vent Valve to remain closed and Sterilizer to cool until Chamber Gauge returns to zero.

10. Close Steam Supply Valve when through sterilizing.

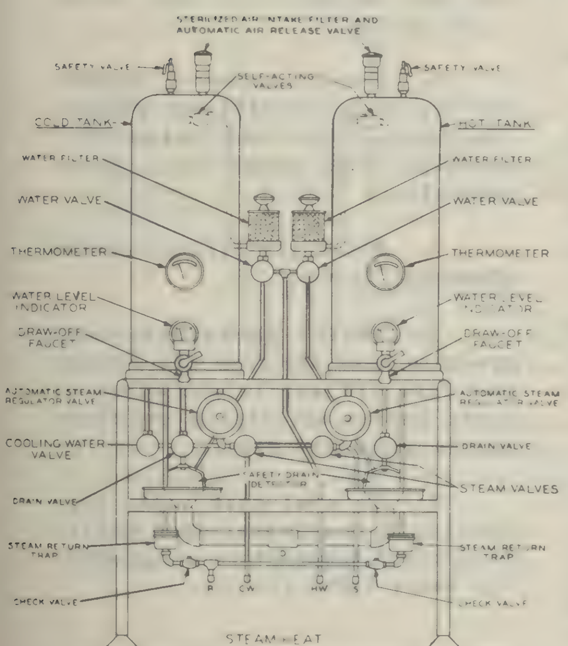
11. Wet dressings will result in *any* Autoclave if -
   a. Steam Valve to Chamber is opened too suddenly, or
   b. Vent Valve is opened before Steam Valve to Chamber is closed, or
   c. Air and Condensation Ejector is out of order.

12. *IMPORTANT* - Raise Safety Valve lever twice a week to insure free movement.

13. If door gasket leaks steam do not force hand wheel - - install new gasket.

14. Wet dressings will result in *any* Autoclave if -
   a. Generator is filled too full, or
   b. Steam Valve to Chamber is opened too suddenly, or
   c. Vent Valve is opened before Steam Valve to Chamber is closed, or
   d. Air and Condensation Ejector is out of order.

OPERATING DIRECTIONS
CASTLE WATER STERILIZERS
STEAM HEAT



1. See that all Operating Valves are closed.

2. To fill Sterilizers, open Water Valve at filter of tank to be filled. Both tanks may be filled at same time by opening both valves. Water Valve must be opened to FULL REACH or water will flow through safety drain at drain detector.

3. Fill tank until Water Level Indicator shows "FULL" - not beyond. (Indicator will show in red zone while tank is under pressure.)

4. When tank is full close Water Valve.

5. Open Steam Supply Valve full.

6. When Thermometer reaches 250° F. begin sterilizing period. (Automatic Steam Regulator will maintain this temperature automatically.)

7. After sterilizing period, close Steam Valve.

8. While tanks are under pressure, open the draw-off faucets and draw off sufficient water to drain faucet and piping and thoroughly sterilize faucet.

9. To cool Cold tank, open Cooling Water Valve; when cooled to desired temperature close Cooling Water Valve tightly.

10. Filters are "Fulflo" cotton fibre, visible through glass casing. When filters become dirty, discard and replace with new filters. (Filters are replaced by unscrewing hand wheels and lifting out filters.)

11. Flush tanks once a week by opening Drain Valve after sterilizing when Thermometer drops to 230° F. For about 5 to 10 seconds.

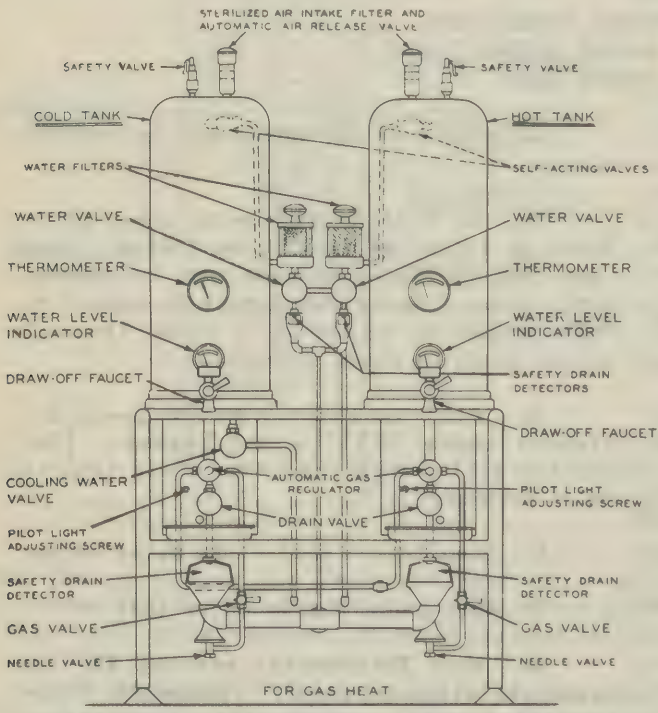
12. *IMPORTANT* - Raise Safety Valve levers twice a week to insure free movement.

OPERATING DIRECTIONS
CASTLE WATER STERILIZERS
GAS HEAT

1. See that all Operating Valves are closed.

2. To fill Sterilizers, open fully Water Valve to tank to be filled. Both tanks may be filled at the same time. (Water Valves must be opened full or water will flow at Safety Drain Detector.)

3. Fill tank until Water Level Indicator shows full. (Indicator will show in red zone while under pressure.)



4. When tank is full, close Water Valve tightly.

5. Light gas burner by opening gas valve. (Be sure pilot light is lit.)

6. When thermometer reaches 250° F. begin sterilizing period. (Automatic Gas Regulator will maintain this temperature automatically.)

7. After sterilizing period close Gas Valve.

8. While tanks are under pressure open the draw-off faucets and draw off sufficient water to drain faucet and piping and thoroughly sterilize faucet.

9. To cool cold tank, open Cooling Water Valve; when cooled to desired temperature close cooling Water Valve tightly.

10. Filters are "Fulflo" cotton fibre, visible through glass casing. When filters become dirty, discard and replace with new filters. (Filters are replaced by unscrewing hand wheels and lifting out filters.)

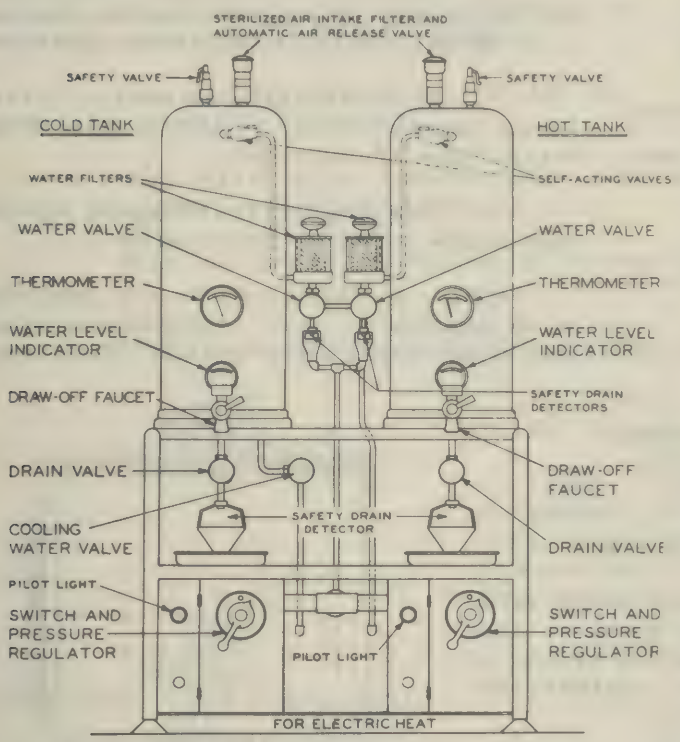
11. Flush tanks once a week by opening Drain Valve after sterilizing when Thermometer drops to 230° F., for about 5 to 10 seconds.

12. *IMPORTANT:* Raise Safety Valve levers twice a week to insure free movement.

OPERATING DIRECTIONS
CASTLE WATER STERILIZERS
ELECTRIC HEAT

1. See that all Operating Valves are closed.

2. To fill Sterilizers, open fully Water Valve to tank to be filled. Both tanks may be filled at the same time. (Water Valves must be opened full or water will flow at Safety Drain Dectector.)



3. Fill tank until Water Level Indicator shows full. (Indicator will show in red zone while under pressure.)

4. When tank is full close Water Valve tightly.

5. Turn switch on Pressure Regulator to 15 pounds.

6. When thermometer reaches 250° F., begin sterilizing period. (Pressure Regulator will maintain this temperature automatically.)

7. After sterilizing period turn switch to "Off" position.

8. While tanks are under pressure, open the draw-off faucets and draw off sufficient water to drain faucet and piping and thoroughly sterilize faucet.

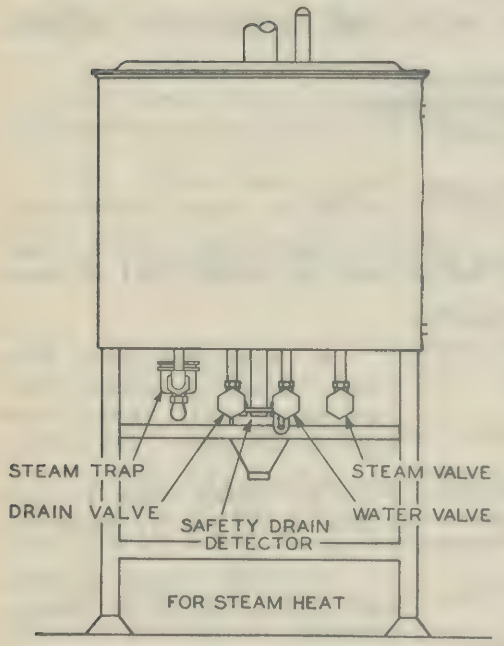
9. To cool cold tank, open Cooling Water Valve; when cooled to desired temperature, close Cooling Water Valve tightly.

10. Filters are "Fulflo" cotton fibre, visible through glass casing. When filters become dirty, discard and replace with new filters. (Filters are replaced by unscrewing hand wheels and lifting out filters.)

11. Flush tanks once a week by opening Drain Valve after sterilizing when Thermometer drops to 230° F., for about 5 to 10 seconds.

12. *IMPORTANT:* Raise Safety Valve levers twice a week to insure free movement.

OPERATING DIRECTIONS
UTENSIL STERILIZER
STEAM HEAT



1. See that all Valves are closed.

2. To fill Sterilizer, open Water Valve FULL. (Unless Water Valve is open full, water will be wasted through safety drain attached to valve.) When contents are covered close Water Valve.

3. Open Steam Supply Valve full. (When Steam Return Valve is furnished open about one turn.)

4. When water boils, turn Steam Supply Valve down to maintain boiling temperature during the entire sterilizing period.

5. After sterilizing period, close Steam Supply Valve. (Also close Steam Return Valve if furnished.)

6. Drain sterilizer once a day and wash inside to remove lime deposit.

VENT: If Sterilizer is not connected to an atmospheric vent, and Condenser Vent is used, open Vent Valve to carry off excess steam during sterilization. Close Vent Valve when thru sterilizing.

OPERATING DIRECTIONS
UTENSIL STERILIZER
ELECTRIC HEAT

1. See that all Valves are closed.

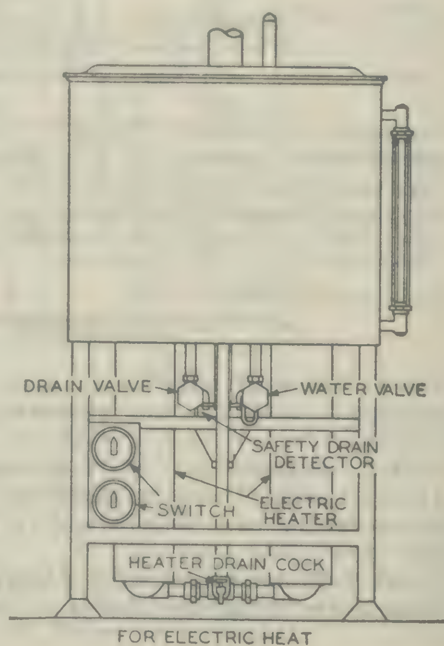
2. To fill Sterilizer, open Water Valve to FULL REACH. (Unless Water Valve is open FULL, Water will issue from Safety Drain, at Safety Drain Detector.) When contents are covered, close Water Valve tightly.

3. Turn Electric Switches to "High".

4. When water boils, turn switches to lowest heat that will maintain boiling temperature during the entire sterilizing period.

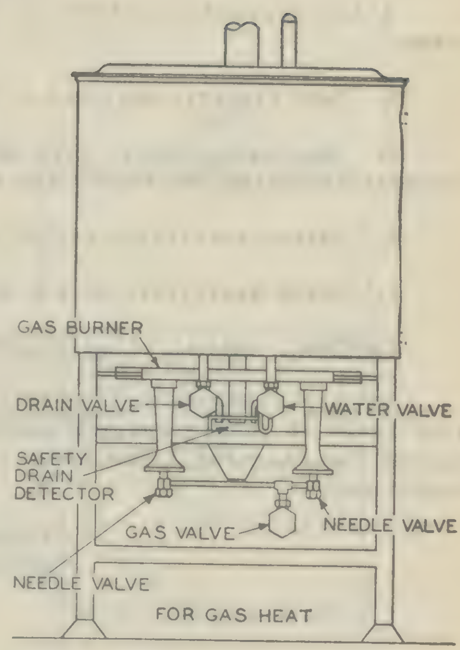
5. After sterilizing period turn switches to "Off".

6. Drain sterilizer once a day and wash inside to remove lime deposit.



CAUTION: Do not allow Sterilizer to run dry.

Heater element, Casing and Pipe Connections must be kept clean and free from scale to ensure maximum heating and circulation. Remove Heater element from casing for cleaning. How often this may be necessary will depend on local water conditions.



OPERATING DIRECTIONS
UTENSIL STERILIZER
GAS HEAT

1. See that all Valves are closed.

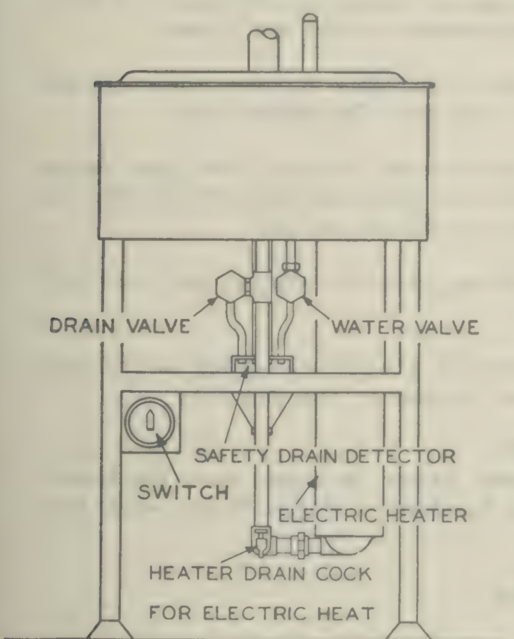
2. To fill Sterilizer, open Water Valve to FULL REACH. (Unless Water Valve is open FULL, Water will issue from Safety Drain, at Safety Drain Detector.) When utensils are covered, close Water Valve tightly.

3. To light Gas Burner, hold flame over burner and open Gas Valve full.

4. When water boils, turn Gas Valve down to maintain boiling temperature, during the entire sterilizing period.

When Automatic Gas Regulator is supplied, gas will automatically regulate.

5. After sterilizing period turn off gas.



6. Drain sterilizer once a day and wash inside to remove lime deposit.

VENT: If Sterilizer is not connected to an atmospheric vent, and Condenser Vent Valve is used, open Condenser Water Valve to carry off excess steam. Close Condenser Water Valve when thru sterilizing.

CAUTION: Do not allow Sterilizer to run dry.

OPERATING DIRECTIONS
INSTRUMENT STERILIZER
ELECTRIC HEAT

1. See that all Valves are closed.

2. To fill Sterilizer, open Water Valve to FULL REACH. (Unless Water Valve is open FULL, Water will issue from Safety Drain, at Safety Drain Detector.) When instruments are covered, close Water Valve tightly.

A two percent solution of soda will help to keep instruments bright and clean.

3. Turn Electric Switches to "High".

4. When water boils, turn switches to lowest heat that will maintain boiling temperature during the entire sterilizing period.

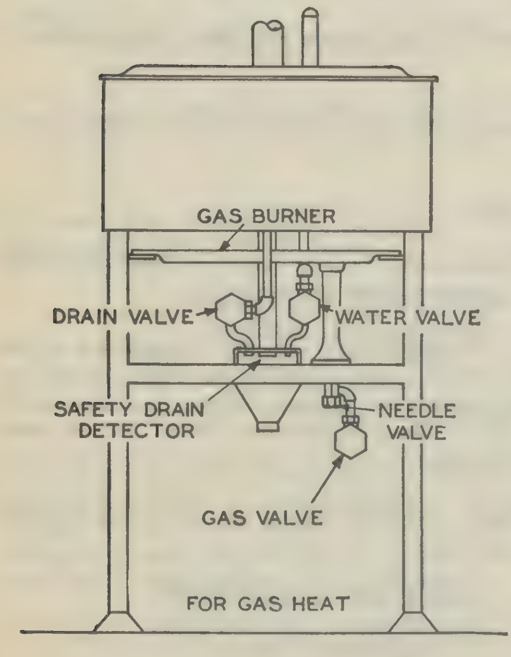
5. After sterilizing period turn switches to "Off".

6. Drain sterilizer once a day and wash inside to remove lime deposit.

CAUTION: Do not allow Sterilizer to run dry.

Heater element, Casing and Pipe Connections must be kept clean and free from scale to ensure maximum heating and circulation. Remove Heater element from casing for cleaning. How often this may be necessary will depend on local water conditions.

OPERATING DIRECTIONS
INSTRUMENT STERILIZER
GAS HEAT



1. See that all Valves are closed.

2. To fill Sterilizer, open Water Valve to FULL REACH. (Unless Water Valve is open FULL, Water will issue from Safety Drain at Safety Drain Detector.) When instruments are covered, close Water Valve tightly.

A two percent solution of soda will help to keep instruments bright and clean.

3. To light Gas Burner, hold flame over burner and open Gas Valve full.

4. When water boils, turn Gas Valve down to maintain boiling temperature, during the entire sterilizing period.

5. After sterilizing period turn off gas.

6. Drain sterilizer once a day and wash inside to remove lime deposit.

VENT: If Sterilizer is not connected to an atmospheric vent, and Condenser Vent Valve is used, open Condenser Water Valve to carry off excess steam. Close Condenser Water Valve when thru sterilizing.

CAUTION: Do not allow Sterilizer to run dry

OPERATING DIRECTIONS
INSTRUMENT STERILIZER
STEAM HEAT

1. See that all Valves are closed.

2. To fill Sterilizer, open Water Valve to FULL REACH. (Unless Water Valve is open FULL, Water will issue from Safety Drain, at Safety Drain Detector.) When contents are covered, close Water Valve tightly.

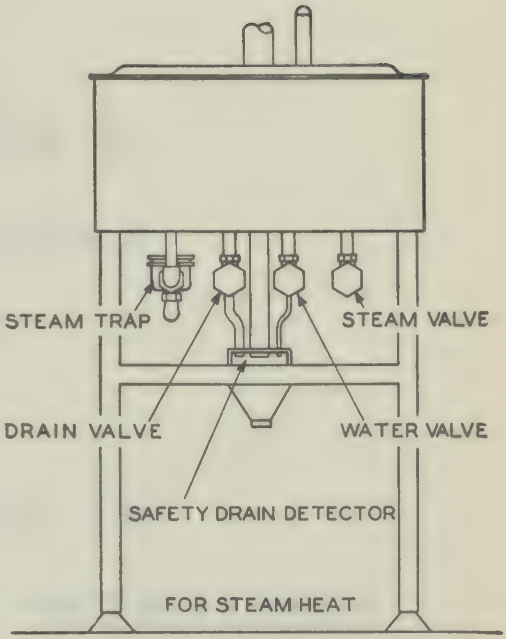
A two percent solution of soda will help to keep instruments bright and clean.

3. Open Steam Supply Valve full. (When Steam Return Valve is furnished open about one turn.)

4. When water boils, turn Steam Supply Valve down to maintain boiling temperature during the entire sterilizing period.

5. After sterilizing period, close Steam Supply Valve. (Also close Steam Return Valve if furnished.)

6. Drain sterilizer once a day and wash inside to remove lime deposit.



VENT: If Sterilizer is not connected to an atmospheric vent, and Condenser Vent Valve is used, open Condenser Water Valve to carry off excess steam. Close Condenser Water Valve when thru sterilizing.

CHAPTER II

STERILIZERS

SECTION 19

SMALL OFFICE STERILIZERS

STERILIZATION OF INSTRUMENTS, UTENSILS, ETC. - The following technique includes preparation of instruments for sterilizing, which is almost as important as sterilization itself. Followed exactly, this technique will prevent practically all rust or injury to instruments and will insure complete sterilization.

Always clean instruments immediately after using, even though they are not to be sterilized at once. If instruments have been used on badly infected cases, soak immediately after using in 5% Lysol solution, before cleaning and sterilizing.

Scrub thoroughly with a brush, using a disinfecting solution or soap and water. Give particular attention to crevices, grooves, joints, etc., where pus, tissue residue or blood clots usually collect. Blood will cause staining, and pus will adhere to rust or tarnished surfaces. If allowed to remain, it will harden and prevent complete sterilization.

After thorough cleaning, place in sterilizer and boil. Water should be at boiling temperature when instruments are inserted. Care should be taken to insert instruments with delicate cutting edges so that these will not be injured by contact,

Be sure entire load to be sterilized is completely submerged--never allow any part to be exposed above the surface of the water. Utensils should be placed on side or bottom down--never bottom up, as this permits air pockets.

During the sterilizing period it is not necessary that water boil vigorously. Vigorous boiling produces no higher temperatures than bare maintenance of boiling point, and has the disadvantage of creating clouds of steam outside the sterilizer and rapid depletion of the water supply.

NEVER ADD FRESH WATER TO STERILIZER DURING STERILIZING PERIOD AS THIS WILL REDUCE WATER TO BELOW STERILIZING TEMPERATURE.

At end of prescribed boiling, remove instruments immediately. Sterilized tongs can be used, or instruments can be rolled out on a sterile towel or cloth. Do not touch with hands, but pick up towel from underneath and wipe instruments dry while still warm.

Place instruments in a tight cabinet, and for maximum safety, re-sterilize just before using. Nail brushes, files, wood sticks, etc., can be kept sterile in a mild Lysol solution.

STERILIZATION OF HYPODERMIC SYRINGES - Hypodermic syringes should be taken apart, except for the stilet, which should be left in the needle. Wash all parts carefully, and wrap each separately in any soft, protective material. Place in sterilizer before water is heated, so that breakage does not result from sudden heating. Boil for 20 minutes in plain water.

CARE OF STERILIZER BOILER AND TRAYS - Most modern sterilizer boilers are solid bronze castings, coated with tin or special nickel plating. Instrument trays are formed of cartridge brass, also nickel plated. These materials cannot rust and should rust be evident it will be due to steel instruments on which the plating has worn thin or scratched, or to mineral deposits in the water supply.

Water when raised to boiling temperature always precipitates certain lime or mineral salts, resulting in scale formation. Fresh water should always be boiled alone in the sterilizer for a few minutes before inserting instruments. The most practical way to check scale formation is by thoroughly rinsing and wiping the

boiler dry each day. Do not allow water to stand in sterilizer overnight.

Should scale form in the boiler through inattention, prepare a 10% hydrochloric acid solution in sufficient quantity to fill the boiler to the top of the scale formation. Boil the solution for 15 minutes. This will loosen scale so it can be scrubbed out with a stiff brush. Then drain solution, rinse boiler thoroughly and wipe dry. Be sure to wipe off under side of cover thoroughly, and do not spill solution on exterior of sterilizer or on cabinet top. If trays are also coated with scale, leave in sterilizer while boiling solution and rinse and dry same as boiler.

CARE OF INSTRUMENTS (Rusting--its cause and prevention) - Rusting is in reality an oxidation or eating away of metal caused by air and moisture. Any steel instrument on which plating has been worn thin or scratched will rust when exposed to air when moist. Rusting is accelerated when instruments are both wet and hot.

Rule No. 1 in rust prevention is to always have instruments completely submerged when boiling. If sterilizing of used instruments is not to be done at once, keep them immersed in sterile water or 5% Lysol solution until ready for cleaning and sterilizing. After sterilizing, instruments should be removed immediately from the sterilizer and wiped dry with sterile cloth while still warm. Never allow them to remain in the sterilizer tray. It is also a good idea to wipe them with sterile muslin moistened slightly with oil before putting away. Oil all surfaces where plating has worn off.

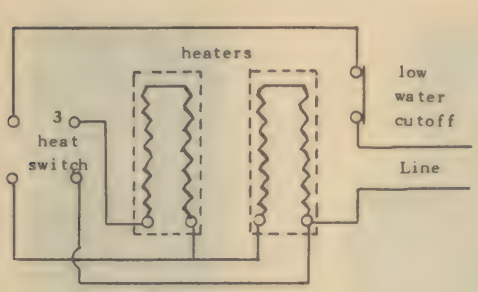
TARNISHING - Most tarnishing of instruments results not from rust but from the precipitation of lime scale from the water. Chemical preparations such as iodine or silver nitrate also cause tarnish.

The most practical way to prevent tarnish from lime scale is to boil water alone in the sterilizer for ten minutes before inserting instruments, and to keep the boiler free of scale by cleaning, rinsing and wiping dry at the end of each day. The use of distilled or rain water is also recommended whenever possible instead of ordinary tap water.

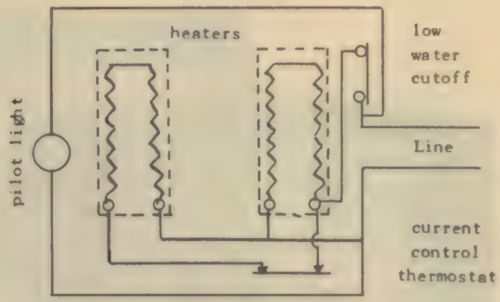
SMALL OFFICE STERILIZERS

PELTON AND CRANE

3 HEAT SWITCH CURRENT CONTROL



AUTOMATIC CURRENT CONTROL



General appearance of Sterilizer

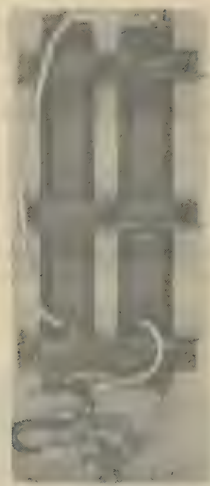
View from Bottom (Automatic Control)

PELTON AND CRANE PORTABLE INSTRUMENT STERILIZER

This sterilizer is made with either 3 heat switch manual control of current, or with Westinghouse thermostat automatic current control. See circuits above. On the manual control type, when the switch is turned to "High" both heaters are in parallel and the maximum current is applied to them. When turned to "Medium" only one heater is in use, thus reducing the current by one half, and when turned to "Low" both heaters are placed in series, thus using but one quarter of the current. On the automatic type, the current is cut in half automatically when the thermostat opens up at approximately 210° F and shuts off one heater. The "on" and "off" switch is housed in the finishing jacket.

Both of these sterilizers use the same style low water cutoff to protect the heaters and the sterilizer should it boil dry. The operation of this control depends upon the expansion of the boiler in relation to a non-expanding porcelain rod. One end of the porcelain rod is permanently anchored to the boiler, the other end is suspended from a trip mechanism by an adjustable coupling. The trip mechanism itself is hinged to a permanent anchor on the bottom of the boiler. The moving contact of the low water cutoff is normally held closed by the trigger of the trip mechanism against a spring which seeks to open it. When the sterilizer boils dry, the boiler expands and the distance between the permanent anchor of the porcelain rod (which does not expand) and the anchor of the trip mechanism is increased; thus a pulling force is created between the anchored porcelain rod and the trip mechanism from which the other end of the porcelain rod is suspended. This pulling force is sufficient to draw the trigger of the trip mechanism and release the plunger of the low water cutoff. A spring on the plunger pushes out the moving contact of the low water cutoff and breaks the circuit. To reset this cutoff, one pushes the plunger back after the sterilizer has cooled somewhat.

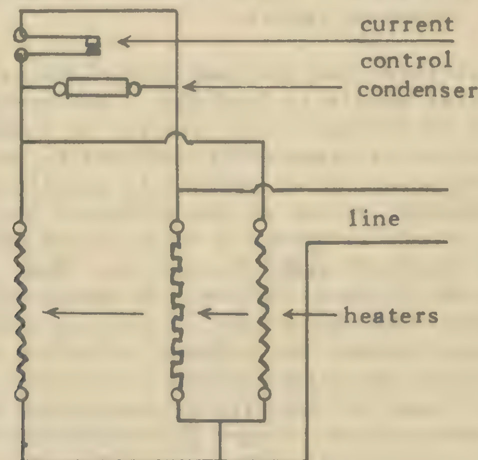
General Appearance of Sterilizer



View from Bottom

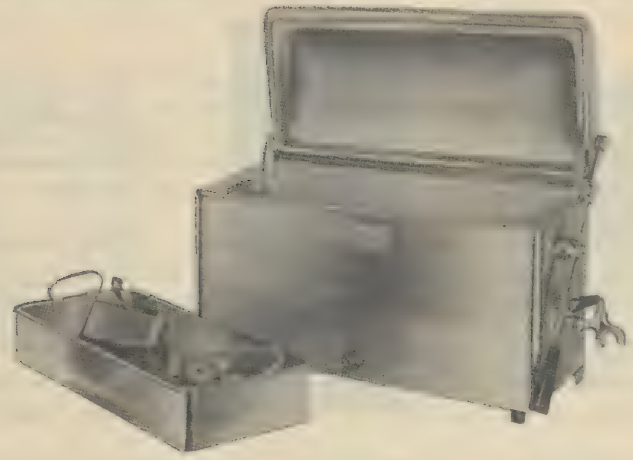
PROMETHEUS PORTABLE INSTRUMENT STERILIZER

This sterilizer has an automatic current control, but no low water cutoff. The "on" and "off" switch is in the line cord. There are two heater blades, one single wound, the other double wound (see diagram). When the sterilizer is first turned on, all the heaters are energized. As soon as the water reaches approximately 210° F, two heaters are turned off by the thermostatic current control, leaving on only the one heater (indicated by squared line in diagram). This heater is of sufficient wattage to bring the water to boiling point and maintain it at this temperature. Should the sterilizer boil dry, this heater still remains energized, but it is so designed that no damage will be done to the heater or the sterilizer. The current control is of the bi-metallic type and the thermostatic element is housed in a glass capsule. There is a condenser across the thermostat to dampen the arc when the contacts break. A pilot light is incorporated in some models, but is not standard on all.



Electric Circuit

SCANLAN MORRIS

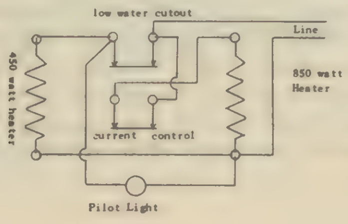


General Appearance of Sterilizer

SCANLAN MORRIS PORTABLE INSTRUMENT STERILIZER

OPERATION - Heating units consist of two steel sheathed imbedded nichrome wire flat iron type heating units, a 450 watt and a 850 watt, total 1300 watts. The heat is turned on by snapping the switch on the cord after the sterilizer is plugged into a standard 15 amp 115 volt AC or DC outlet. As the water in the sterilizer starts to boil (about 205° F) the boiling control thermostat opens the circuit to the 850 watt heating unit, leaving the 450 watt unit on to keep the water constantly boiling. If the water should boil away, the low water thermostat then opens the circuit to the 450 watt heating unit until the temperature of the body casting drops to a safe level. If left without water, this thermostat limits the heat input so as to keep the contents of the tray in the sterilizer at a safe temperature. The pilot light burns when the sterilizer is heating. This sterilizer employs the Westinghouse thermostat in the same manner as the Castle sterilizer.

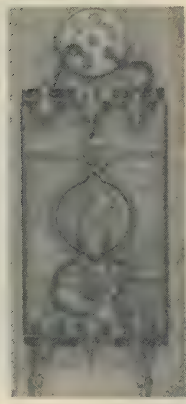
The on and off switch is incorporated in the line cord.



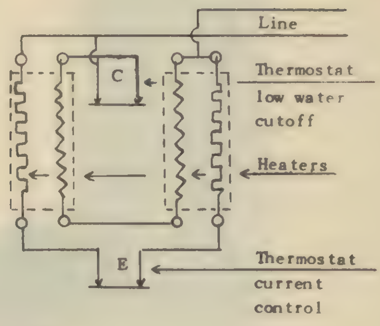
Electric Circuit

WILMOT CASTLE

General appearance of Sterilizer.



View from Bottom.



Electric Circuit.

WILMOT CASTLE PORTABLE INSTRUMENT STERILIZER

OPERATION - This sterilizer has an electrical circuit incorporating what is known as full automatic current control. The "on" and "off" switch is in the line cord. Two Westinghouse thermostats are used, one marked "E" which is the current control and one marked "C" which is the low water control. The heaters are double wound, by this it is meant that half of each heater circuit is wound on each heater blade (see diagram) this gives even distribution of heat over the bottom surface of boiler and assures an even temperature in the sterilizer.

When the sterilizer is first turned on both thermostats are closed thus applying full heater capacity, in order to quickly heat the water in the sterilizer, as soon as a temperature of approximately 210° F. is reached the "E" thermostat opens and shuts off one heater circuit or about 2/3 of the total heater capacity, the remaining heater circuit is of sufficient wattage to bring the sterilizer to a boil and to keep it at boiling point. Should the sterilizer boil dry the "C" thermostat or low water control opens and shuts off the balance of the current, thus protecting the heaters and sterilizers from damage.

To reclose the thermostats pour in cold water. Note when the sterilizer is dry and the "E" thermostat is open, no current is being applied to heat the sterilizer. Therefore it will cool down, as it cools the "C" thermostat will of course close and heat will be applied to the sterilizer until the thermostat again opens. Thus when sterilizers using this type control are running without water this cycle will be repeated, until the sterilizer is either refilled with water or turned off. However, the current consumption when running dry is negligible. Since only approximately 1/3 of the heater wattage is on for about two minutes out of every fifteen.

AMERICAN
DIRECTIONS FOR SETTING UP AND USING
4" x 6" x 14" PORTABLE INSTRUMENT STERILIZER

This Sterilizer is ready for use upon removal from carton and cord is plugged into electric outlet.

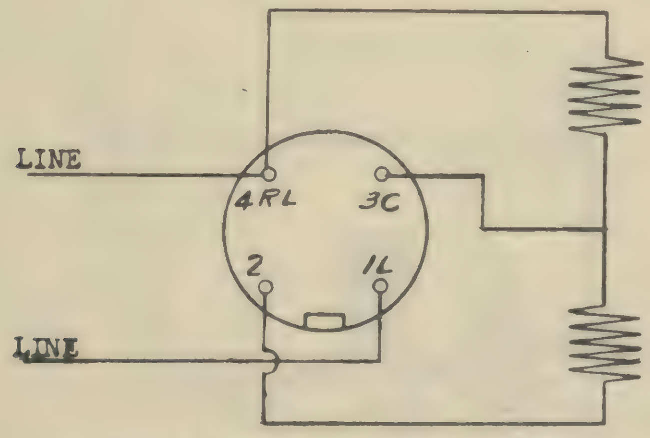
DIRECTIONS FOR USE - Fill the Sterilizer with water to a depth sufficient to cover instruments. Now turn on the switch to "HIGH". When water begins to boil, turn switch to "MED", or "LOW", providing just enough heat to keep water boiling mildly without creating excess steam. Mildly boiling water has exactly the same sterilizing value, is just as hot, as if it were boiling vigorously.

If water exhausts while switch is turned on, all current will be cut off Automatically. Current will not flow again until low-water cut-out switch is manually reset, by pushing down lever on R. H. side of Box. Cut-out switch cannot be reset until the heater has been cooled.

Exacting Hospital technique requires boiling of instruments for 20 minutes. In emergency, at request of Surgeon, period of boiling may be reduced to 10 minutes.

This Sterilizer is intended for Operation at the voltage rating stamped on Name plate, for either A. C. or D. C. Circuits. It has a dependable automatic low-water cut-out and 3 heat snap switch.

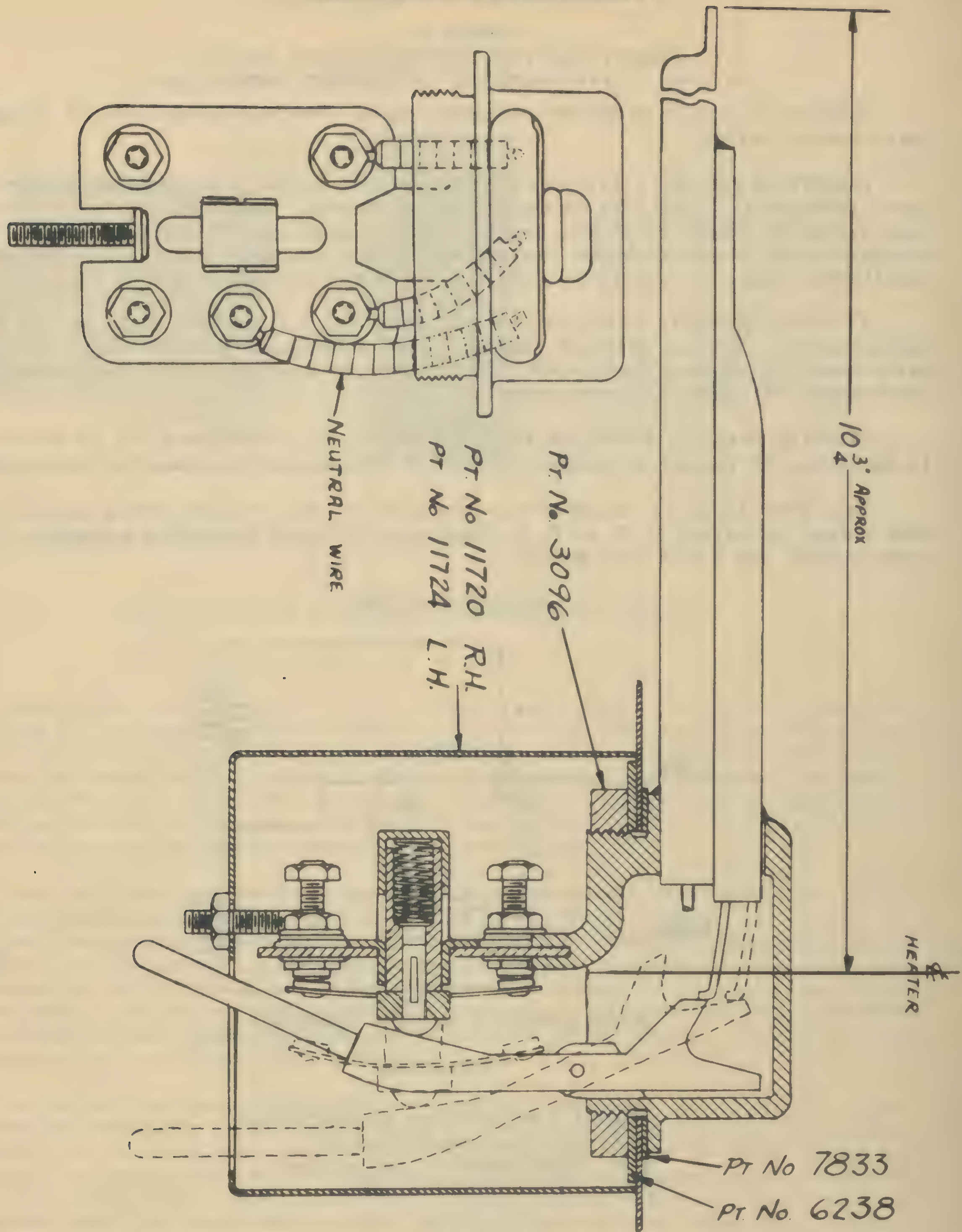
WIRING DIAGRAM



SINGLE POLE - SERIES PARALLEL

OPERATION

High - Two heaters in parallel
Medium - one heater only
Low - Two heaters in series
Off - Both heaters off



AMERICAN
ELECTRIC CUTOUT HEATER ASSEMBLY-TYPE "D"
1600 WATTS A.C. OR D.C.

CHAPTER II

STERILIZERS

SECTION 20

PROMETHEUS STERILIZERS

DIRECTIONS FOR OPERATING INSTRUMENT STERILIZERS - ELECTRIC HEAT
20" x 10" x 9"

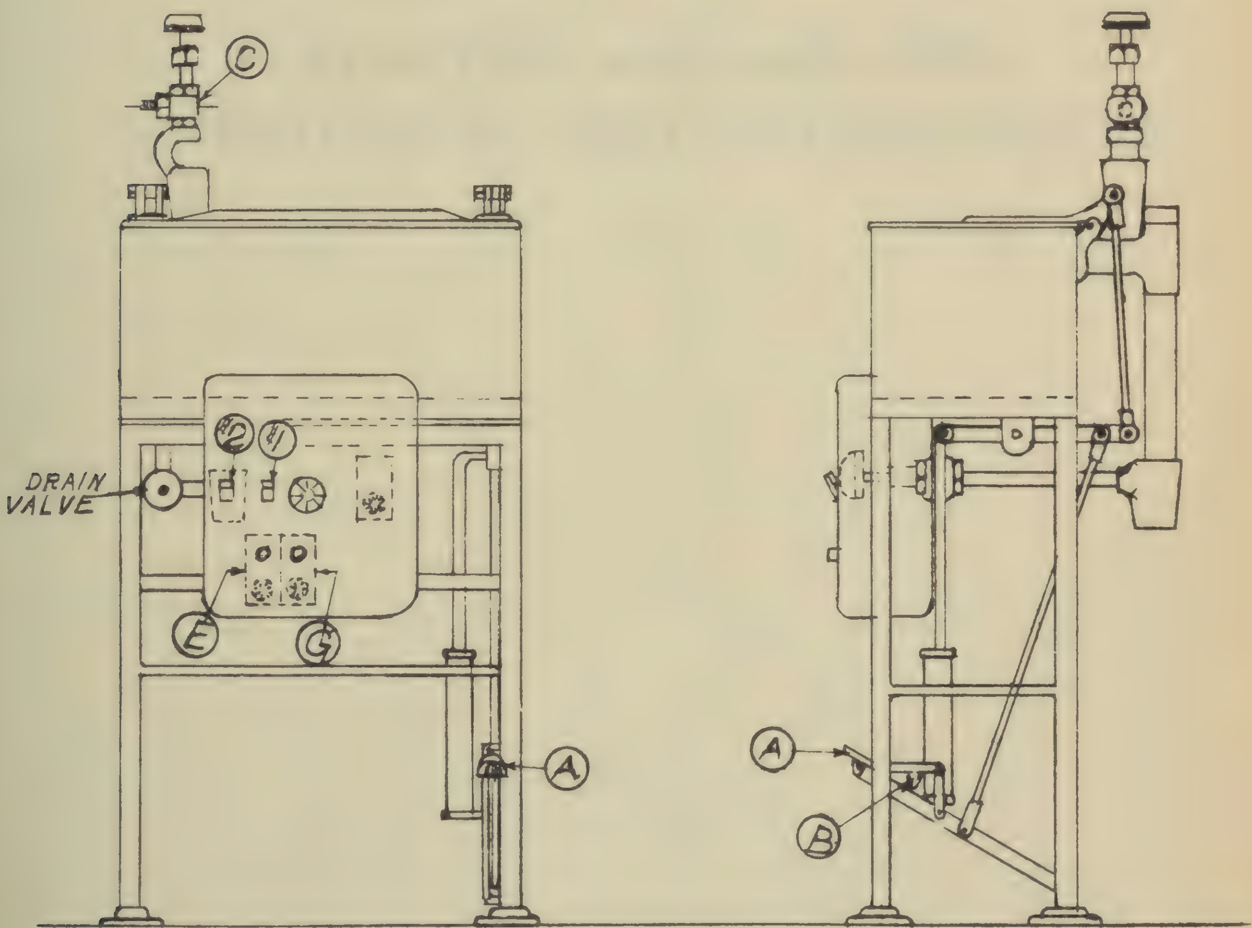
Raise cover by depressing lever "A". Place instruments on tray and lower to the bottom of the tank by pushing in release knuckle "B". Open valve "C" and allow enough water to enter tank to cover all instruments.

To operate on full heat, throw both switches to the "on" position. The water will then come to a boil rapidly. When water is boiling vigorously, to decrease steam generation, throw switch #2 to the "off" position. The sterilizer will then operate on half heat, subject to the automatic boiling control. To disconnect sterilizer, throw both switches to the "off" position.

IMPORTANT - If the sterilizer should boil dry, the low water controls will operate to prevent damage to the sterilizer. After these controls have operated, in order to use the sterilizer again, proceed as follows:

(1) Throw switches #1 and #2 to "off" position.
(2) Fill sterilizer with water.
(3) Reset both low water controls "E" and "G" by pushing in re-set buttons.
(4) Throw switches #1 and #2 to "on" position.

It is important to follow this sequence of operation.



CHAPTER III

DIAGNOSTIC EQUIPMENT

SECTION 1-A

ELECTROCARDIOGRAPHS
- HISTORICAL AND PHYSIOLOGICAL -

ELECTROCARDIOGRAPHS

HISTORICAL AND PHYSIOLOGICAL

DEFINITION

ELECTROCARDIOGRAPH - An electrical instrument for recording potentials developed during heart actions.

ELECTROCARDIOGRAM - A photographic representation of the electrical activity of the heart.

HISTORY OF CARDIAC DIAGNOSTIC PROCEDURES

In 1760 Auenberger was the first to demonstrate that by percussion it was possible to locate the heart border in the chest and thereby laid the foundation for one of the most widely used items in clinical examinations.

In 1816 Laennec discovered that heart sounds were more audible if a tube of rolled paper was used. From this was later developed the stethoscope.

The next step was when Stephan Hale demonstrated blood pressure which was later perfected by Ludwig.

In 1856 Koelliker and Mueller demonstrated the presence of an electrical current in the heart.

In 1867 Potain made the first graphic record of the heart's electrical activities.

In 1887 Waller using a capillary electrometer was the first to demonstrate the possibility of registering these electrical currents of the human heart.

In 1892 Bayliss and Starling by improving the sensitivity of the capillary electrometer was able to make more satisfactory curves.

The next forward step was Roentgen's discovery of X-Ray which made visualization of the heart possible.

In 1903 Einthoven perfected and introduced the string galvanometer and in 1906 and 1908 the results of his first clinical study were published.

In 1926 the amplifier type of electrocardiograph was introduced.

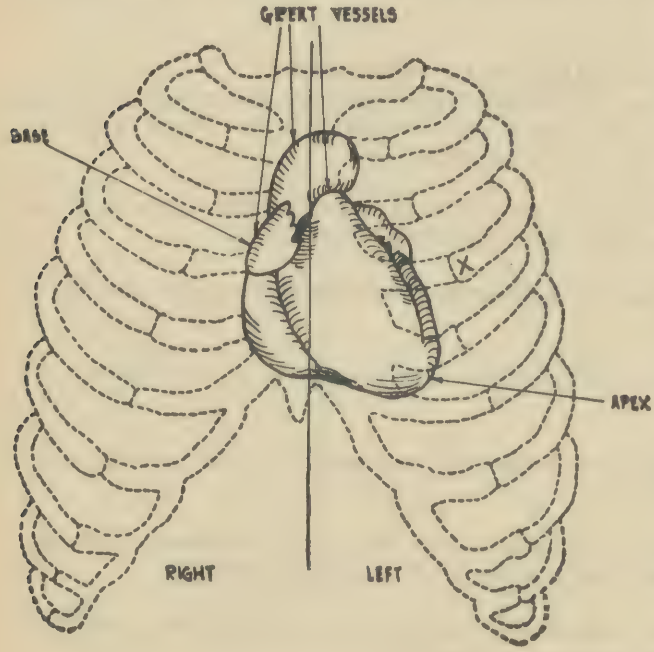
THE HEART - In a normal adult, the heart is a hollow, muscular organ, situated in the thorax between the lungs. It is shaped somewhat like a blunt cone. The broad end is called the base and that region is the *basal* region. The pointed end is the *apex* and that region is spoken of as being *apical*. It is suspended in position by the great vessels, so that the base, or broad end, is upward, backward and to the right. The apex is downward, forward and to the left.

PERICARDIUM - The heart is enclosed in a membranous sac called the pericardium (around the heart).

ENDOCARDIUM - The interior portion of the heart is lined by a smooth delicate membrane, called the *endocardium*. This pavement membrane lines all the cavities of the heart and is continued into the blood vessels, forming their innermost coat.

MYOCARDIUM - The heart is composed chiefly of muscle characteristic of this organ. It shows some striation resembling voluntary muscle and also bears relation to the smooth or plain muscle of the body. The term *myocardium* is used when referring to the muscle of the heart.

THE CAVITIES OF THE HEART - The heart is divided from apex to base by a septum, or partition, which is fixed in position, separating the heart into a right and left half frequently called the right and left heart. The two sides of the heart have no communication with each other after birth. The right side always contains *venous* blood (the blood which comes from the veins). The left side contains only *arterial* blood. Each side of the heart is divided into two cavities, the upper called the auricle; the lower, ventricle. Thus we have the right *auricle* and *right ventricle* on the *right side of the heart and the* left *auricle* and *left ventricle* on the left side of the heart.



Heart in position (Dalton, in Flint, "On the heart"). X on fourth rib, nipple.

An examination of the heart shows that the muscular walls of the auricles are much thinner than those of the ventricles, and likewise, the wall of the left ventricle much thicker than the right (the proportion being slightly more than 2-1). This difference in bulk is to be accounted for, as we shall see later on, by the varied amount of work the various cavities of the heart have to do.

Between the right auricle and right ventricle and between the left auricle and left ventricle are orifices, or openings closed by valves.

IMPORTANT ORIFICES OF THE HEART - Eight large blood vessels are connected with the heart. On the right side of the heart the superior and *inferior vena* (vein) *cava* empty into the right auricle and the pulmonary artery leaves the right ventricle. On the left side of the heart four *pulmonary veins* empty into the left auricle and the aorta leaves the left ventricle. There are also the two orifices between the auricles and ventricles.

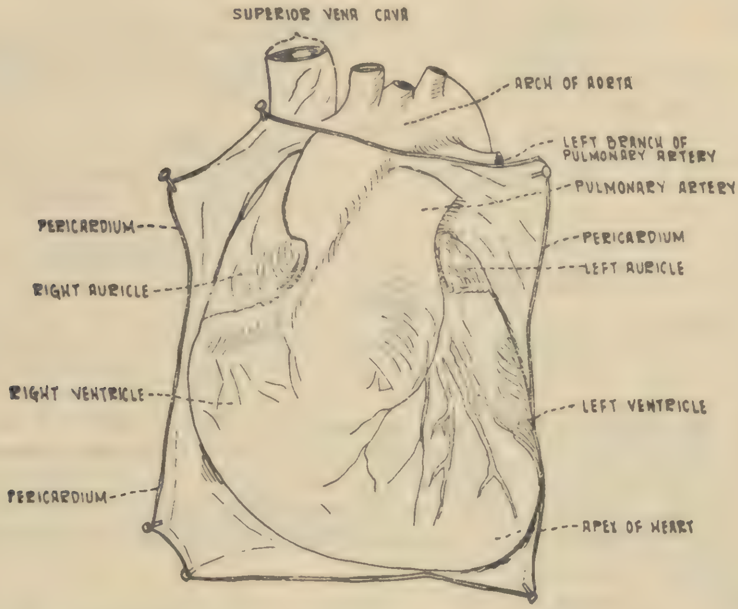
VALVES OF THE HEART - The auriculo-ventricular orifices - the aorta and pulmonary artery are guarded by valves.

TRICUSPID VALVE - The valve guarding the right auriculo-ventricular opening is composed of three irregular shaped flaps, or cusps and hence is named tricuspid. The flaps are formed of fibrous tissue covered by endocardium.

BICUSPID VALVE - The valve guarding the left auriculo-ventricular opening consists of only two flaps or cusps and is named bicuspid or *mitral* valve. It closely resembles the tricuspid valve except that it is much stronger and thicker in all its parts.

FUNCTION - These valves place no obstacle to the passage of blood from the auricles into the ventricles because the free edges of the flaps are pointed in the direction of the blood flow; but any flow forced backward (ventricle to auricle)

gets between the flaps and the wall of the ventricle and drives the flaps upward, until meeting at their edges, they unite and assume a complete transverse position between the ventricle and auricle, thereby forming a blocking partition.



The heart enclosed in the pericardium seen from in front. The pericardium has been opened in front (Sobotta and McMurrich)

SEMILUNAR VALVES - In the aorta and pulmonary artery, just as they leave the ventricles are the semilunar valves. They consist of three small half-moon-shaped pockets, each pocket being attached by its convex border to the inside of the artery, while its other border projects into the interior of the vessel.

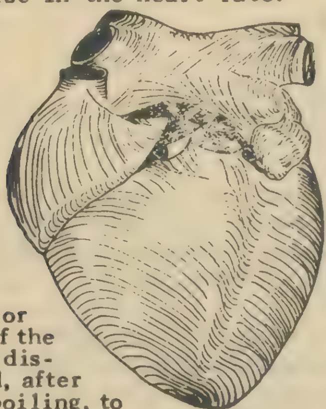
FUNCTION - These valves offer no resistance to the blood flow from the ventricles into the arteries. Should the blood flow start backwards, the pockets become filled and the free edges are floated out and so distend that they meet in the center of the artery, closing the passage.

The orifices of the heart which open into the veins are not protected by valves, with the possible exception of the opening into the inferior vena cava which is partly covered by a membrane known as the *Eustachian Valve*.

THE ARTERIES AND VEINS OF THE HEART - Just after the aorta leaves the left ventricle, it gives off two small branches called the right and left coronary arteries. These encircle the heart like a crown, hence their name. They supply the substance of the heart with blood, as the blood contained within the cavities of the heart only nourishes the endocardium. The return of the blood is through two main pathways: veins corresponding to the coronary arteries bring the blood into a large vessel, the *coronary sinus*, to empty into the right auricle and numerous small veins, the *venae thebesii*, which return the blood directly. These open chiefly into the right auricle.

Heart	Valves	Ariculo-ventricular valves	Tricuspid between right auricle and right ventricle
			Mitral (bicuspid) between left auricle and left ventricle.
		Semilunar Valves	Pulmonary semilunars on right side. Aortic semilunars on left side.
	Orifices	Entering ones	Superior vena cava on right side.
			Inferior vena cava on right side.
			Pulmonary veins on left side.
		Emerging ones	Pulmonary artery on right side.
			Aortic artery on left side.
		Between auricles and ventricles	Tricuspid on right side
			Mitral (biscupid) on left side.

NERVES OF THE HEART - The heart is supplied by two sets of nerves: 1) the vagi from the central nervous system and (2) nerves from the *sympathetic system*. Both sets are connected with a group of nerve-cells in the medulla, the cardiac center. Through the center either set may be stimulated. Impulses over the vagi result in slowing of the heart; impulses over the sympathetic nerve produce an increase in the heart-rate.



Anterior view of the heart, dissected, after long boiling, to show superficial muscles (Quain)

This nervous system does not originate the heart beat - it merely controls the rate, force and rhythm.

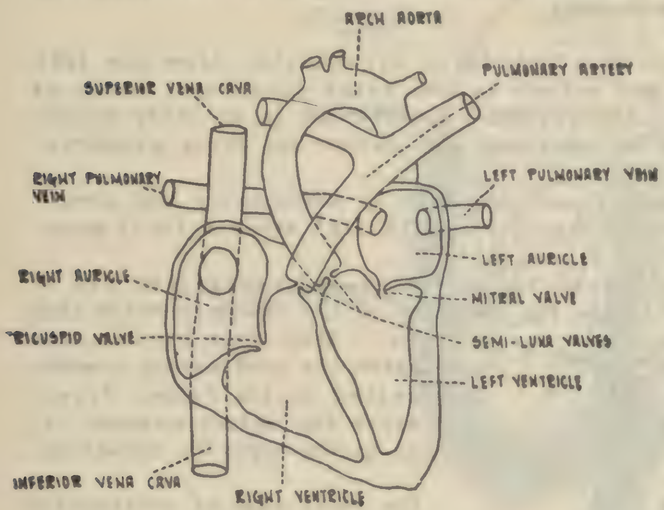
SPECIAL TISSUES OF THE HEART - This term is employed to describe certain tissues in the heart which are concerned with the initiation and propagation of the heart beat. Later on when discussing the action of the electrocardiograph and the cardiogram the special tissues will become of great importance. They include the sino-auricular node and the junctional tissue.

SINO-AURICULAR NODE - The sino-auricular node is composed of neuromuscular tissue and is located in the right auricle, at the junction of the superior vena cava and the auricle. The node is approximately one-half inch long and is under the influence of the nerve system already mentioned. It is at this node that the stimulus which causes the *heart beat* is originated. For this reason it is often called the pacemaker of the heart.

STRUCTURES OF THE JUNCTIONAL TISSUES - The junctional tissue is made up of the auriculo-ventricular node, (A-V node for short), the bundle of His, right and left branches of the bundle and the terminal endings of the branches or arborization (known as the fibres of Purkinje). The junctional tissue is all one continuous structure, but is divided as above for convenience.

This tissue as we shall see later serves as the bridge or connecting link between the auricles and ventricles for conducting the stimulus which originated at the sino-auricular node and causes the heart beat.

THE A-V NODE - This node which is the very beginning of the junctional tissue is located at the base of the *interauricular* septum or partition between the auricles. It is on the right side, therefore being in the right auricle. It is made up of neuromuscular tissue which is true of all the rest of the junctional tissue.



Showing cavities of heart, also important openings and location of valves (Pearce and MacLeod)

BUNDLE OF HIS - This bundle, one end of which is the A-V node, runs along the top of the interventricular septum and near the aortic valve, splits into two branches, one branch (the right) enters the right ventricle, and the other (left branch) enters the left ventricle.

FIBRES OF PURKINJE - The right and left branches of the bundle of His split up into many fine terminal endings which spread and cover nearly all the ventricular surfaces. These small fibres (the arborization) are known as the *fibres of Purkinje*.

THE GENERAL CIRCULATION OF THE BLOOD - The heart and the blood vessels form a closed vascular system containing a certain amount of blood. This blood is kept in endless circulation, mainly, by the force of the muscular contraction of the heart.

To trace the general circulation we will begin with the venous blood which has been used by the body and is being returned to the right auricle of the heart through the superior and inferior vena cava by the veins. It enters and fills the the *right auricle* and the *right ventricle*. *(It* is a mistake to think that the blood all accumulates in the auricle before any is forwarded to the ventricle). Then the auricle contracts (simultaneous with the left auricle) and forces the blood through the open valve into the ventricle which has already been passively filled and now becomes well distended by the extra supply. After a brief pause (1/10 of a second or less) the ventricle contracts and forces the blood over the open semilunar valves into the pulmonary artery. The pulmonary artery divides into two branches and carries the blood to each lung where it passes through the innumerable capillaries that surround the air sacs of the lungs and the changes in the blood take place (purifying). These capillaries unite to form veins and these unite to form larger veins until finally two pulmonary veins return the blood from each lung to the left *auricle* and *ventricle*. The left auricle now contracts and forces the blood over the open bicuspid valve into the left ventricle just as described for the right side of the heart. The bicuspid valve is closed in the same way as the tricuspid and after a pause the left ventricle contracts forcing the blood over the open semilunar into the aorta. From the aorta and its branches the blood travels in the capillaires to all parts of the body. The capillaries unite then to form veins and finally the blood is returned by means of the superior and inferior vena cava go the right auricle of the heart, which completes the circuit.

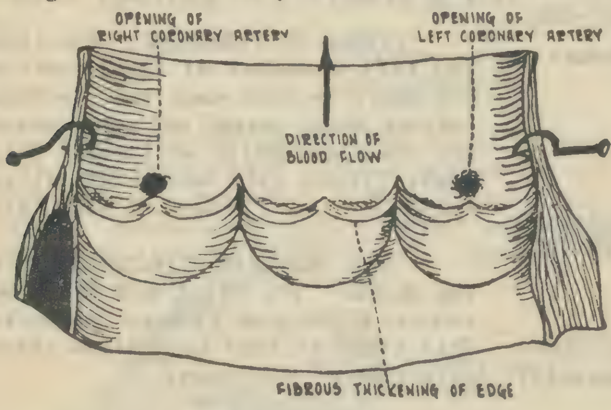
THE PULMONARY CIRCULATION - The lesser circulation from the right auricle to the right ventricle, through the pulmonary artery to the lungs and back through the pulmonary veins to the left auricle is called the *pulmonary circulation*.

The purpose of the pulmonary circulation is to carry the blood which has been used or has been through the system giving up oxygen and collecting carbon dioxide to the air sacs of the lungs where the red cells are recharged with oxygen and the carbon dioxide is reduced to a standard amount.

THE SYSTEMIC CIRCULATION - The more extensive circulation from the left ventricle to all parts of the body and return to the right auricle is known as *systemic circulation.* The purpose of the systemic circulation is to carry oxygen and nutritive material to all parts of the body and gather up waste products.

This double circulation, pulmonary and systemic is constantly and simultaneously going on, as each half of the heart is in a literal sense a force pump.

THE HEART AS A PUMP - The muscles of the auricles and ventricles are so arranged that when they contract they lessen the capacity of the chambers which they enclose. When this happens the blood from the contracting chamber is expelled in the proper direction since the valves prevent its passage in the opposite direction.



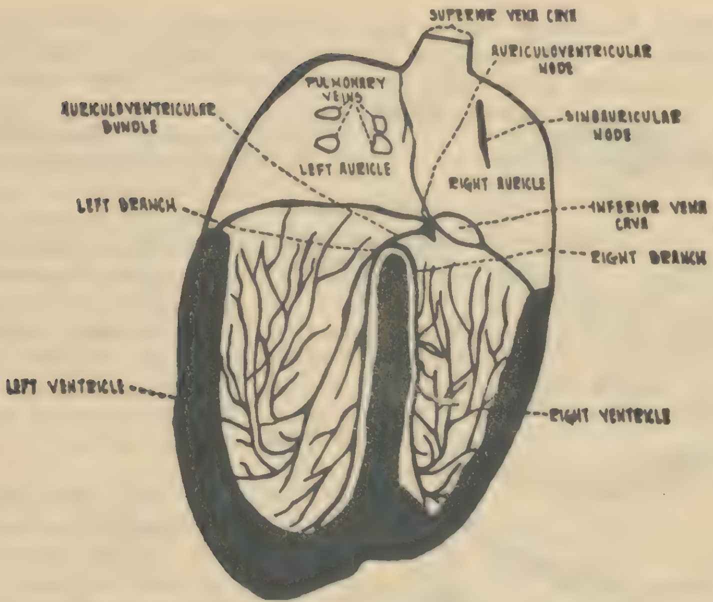
Aortic Valve. The artery has been cut open and spread out (Gerrish)

The first sign of contraction is noted at the sino-auricular node in the right auricle. From this spot the wave of contraction spreads over the muscular walls of the auricles and they contract simultaneously, driving the blood into the ventricles. The contraction wave then reaches the *A-V node* of the junctional tissue and sets up a stimulus which passes through the Bundle of His, the right and left branches, and, finally, the fibres of Purkinje where it is transmitted to the surface of the ventricles. The ventricles then contract and force the blood to the lungs and body.

There is no muscular connection between the auricles and ventricles - the only connection being via the junctional tissue.

RELATIVE SIZE OF MUSCULAR WALLS OF THE HEART - It has been mentioned that the walls of the left ventricle were much thicker than those of the right ventricle. It is also true that the walls of the ventricles are much heavier than those of the auricles. This is now easily explained since it can be seen that the amount of work to be performed by each part of the heart varies. The auricles have only to send the blood to the ventricles and being above them gravity helps. As a consequence, the muscular effort required is not great and the walls therefore are thinner than those of the ventricles which have much more work to perform. The right and left ventricles differ because the right ventricle has only to force blood through the lungs while the left has to supply the entire body.

THE HEARTBEAT - By a heartbeat is meant a coordinated contraction of the cardiac muscle resulting in the expulsion of the blood. It consists of (1) an active phase or period of contraction which is called the systole, and (2) a passive phase or period of dilatation and rest called the diastole. The period of diastole you can see includes the filling and rest. Quite often the period of rest is



A diagrammatic view of the heart from behind and somewhat below (Pardee). This illustration differs from others in this article, in that right and left sides of heart are reversed.

considered separately as the diastasis or pause. The combination of the systole and diastole constitutes a cardiac cycle and corresponds to the heartbeat. The heart of a man at rest may beat seventy-five times a minute. Some individuals have a lower rate and some higher. The rate may be doubled by exercise. When a normal heart rate is spoken of, it is meant the rate of an individual in a condition of mental and physical repose. Even under these conditions the rate varies with different people and age and also sex. The pulse rate of a woman is usually higher than that of a man and this seems to hold through all periods of life. The table will prove interesting in showing average rate change with age.

At birth	140
Infancy	120
Childhood	100
Youth	90
Adult Age	75
Old Age	70
Extreme Age	75-80

TIME RELATIONS OF SYSTOLE AND DIASTOLE - The duration of the separate phases of the heart beat depends naturally on the rate of beat. Assuming a low pulse rate of 70 per minute the average duration of the different phases may be estimated as follows:

Ventricular systole			0.379	Sec.
Ventricular diastole and pause			0.483	Sec.
Auricular systole	0.1	to	0.17	Sec.
Auricular diastole and pause	0.762	to	0.692	Sec.

HEART SOUNDS - Normally there are two important heart sounds, one at the beginning, the other at the end of the ventricular systole. The first sound has a deeper pitch and is more prominent than the second. This relative pitch and duration are frequently represented by the sylables lubb-dup. The first sound is attributed to two factors--a valvular element due to vibration of the auriculo-ventricular valves and a muscular element due to vibration of the contracting muscular tissue. The second sound follows immediately the closure of the semilunar valves and undoubtedly is due to the vibration setup in these valves by their sudden closure.

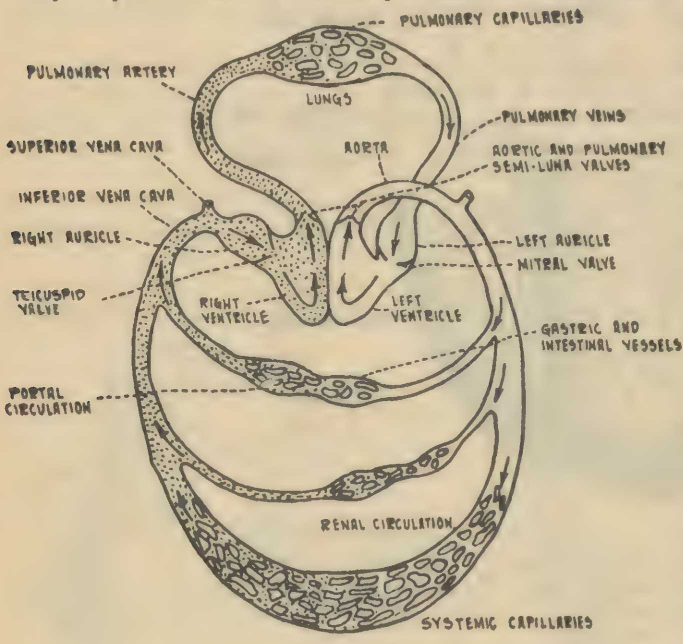


Diagram of circulation. Arrows show direction or blood flow. Shaded portion of heart is right side, light portion is left side (Halliburton).

THE PHYSICS OF ELECTROCARDIOGRAPHY - Let us now briefly recall what occurs in a contracting muscle fiber. If two wires from a galvanometer are connected to the ends of a muscle fiber AB and this fiber is stimulated to contraction so that a positive EMP is developed at A, whereas the electrical potential at B is negative, a current will flow from A to B as indicated on the galvanometer. The muscle fiber then returns to rest, and while doing so a current is produced in the opposite direction. This is the so-called diphasic action current. This of course takes place in contracting cardiac muscle. It was this fundamental principle that led Einthoven to the development of the electrocardiograph with the string galvanometer.

Let us again recall another fundamental physical law, viz: "A conductor conveying a current of electricity if suspended in a magnetic field will move at right angles to the lines of force of the magnetic field." The degree of movement is directly proportional to the strength of the current. With these fundamentals in mind, Einthoven constructed the first string galvanometer electrocardiograph consisting of:

1. String conductor of fine spun quartz plated with gold.
2. Electromagnet, within which the conductor was suspended.
3. A source of light to project the shadow of the string.
4. A microscope to magnify it and motor operated camera with timer to record string movement.

This worked as follows:

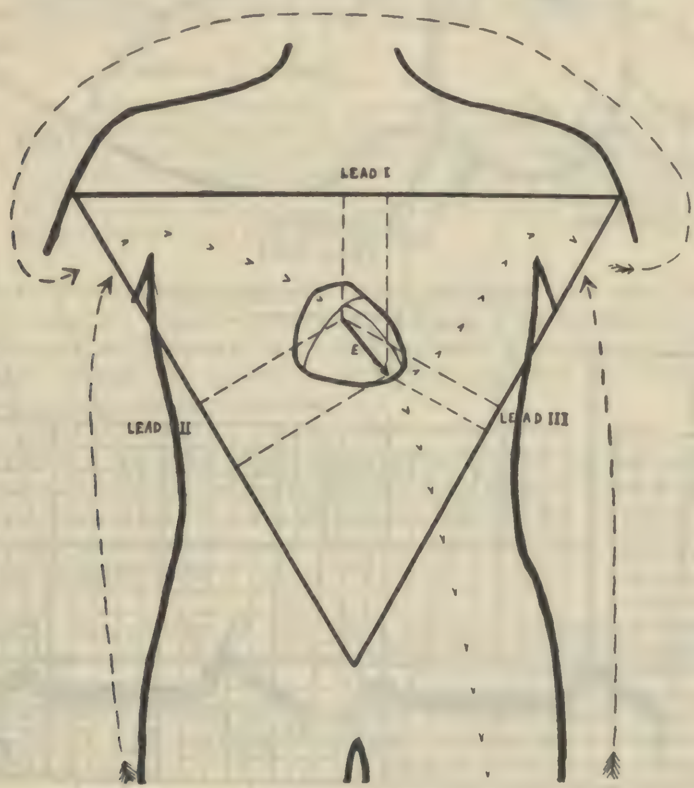
Through the medium of electrodes attached to the body the conductor picked up the minute currents generated by the heart, and oscillation of the conductor was photographed on specially ruled sensitized paper. Experience determined where satisfactory contacts could be made on the body and eventually standard leads were established, consisting of:

Lead I Left arm - Right arm
Lead II Right arm - Left leg.
Lead III Left leg - Left arm.

These leads form a triangle about the heart and the combined information from the three tracings presents certain pertinent data relative to heart position in the chest.

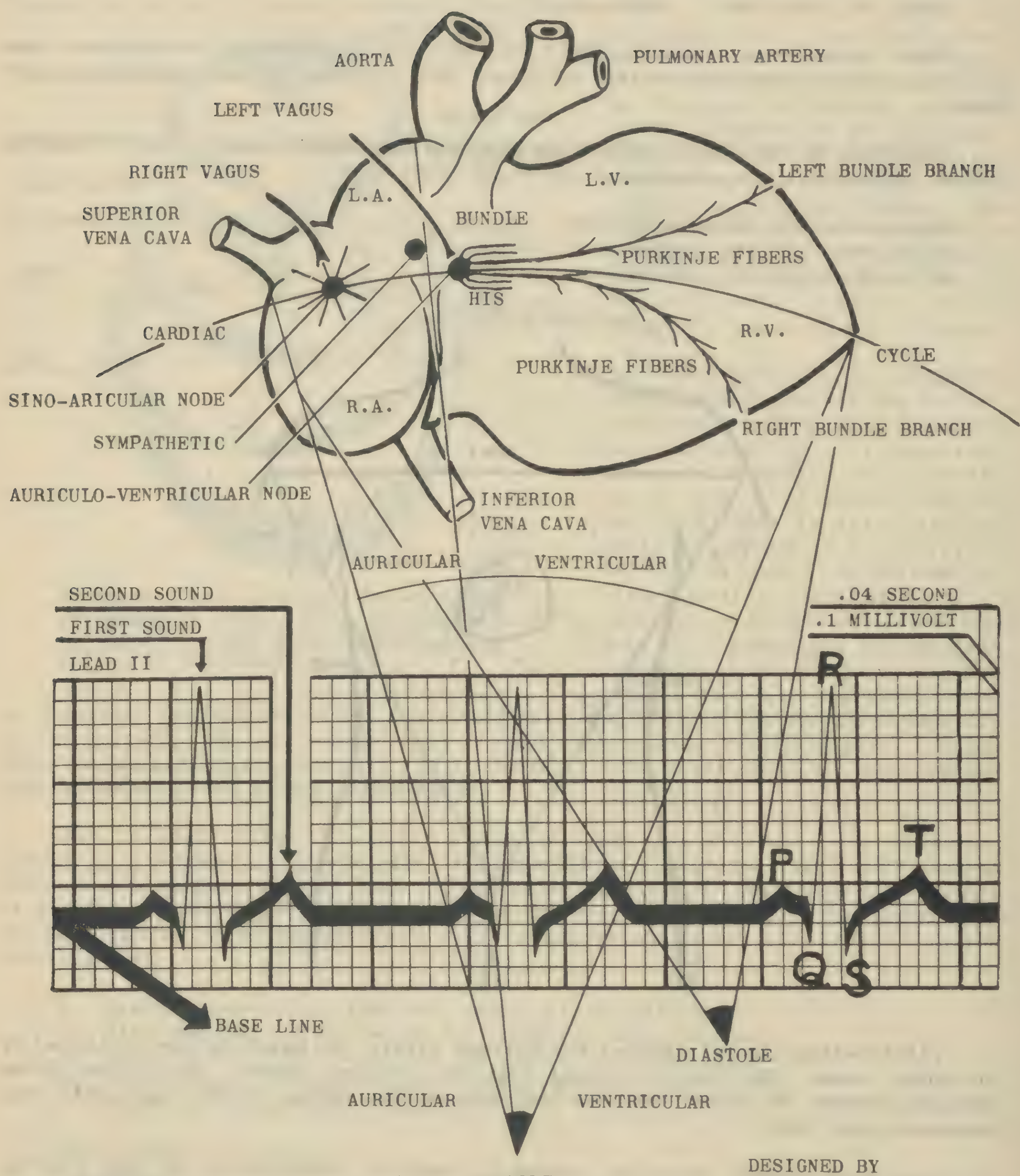
RELATION OF THE HEART CURRENT TO ELECTROCARDIOGRAPH LEADS - The following diagram illustrates the relation of the three leads, viz:

Right arm--left arm, called Lead 1
Right arm--left leg, called Lead 2
Left arm --left leg, called Lead 3



Illustrating the relation of the current within the heart to that obtained by the three leads. The body is viewed from the anterior aspect. Each side of the triangle between the right arm, the left arm and the region of the legs (left leg) represents one lead.

A current within the heart (arrow E) would be represented in each lead by excursions of the same size relative to each other as the projections of this arrow upon the sides of the triangle. The line of arrowheads passing through the body from right arm to left arm represents the flow of current in Lead I(1), and the circuit is completed outside the body through the galvanometer as indicated by the long dotted arrow between the two arms. The flow within the body is indicated for Lead II(2) by a line of arrowheads passing from right arm to left leg. The return



SEPTEMBER 25th 1929

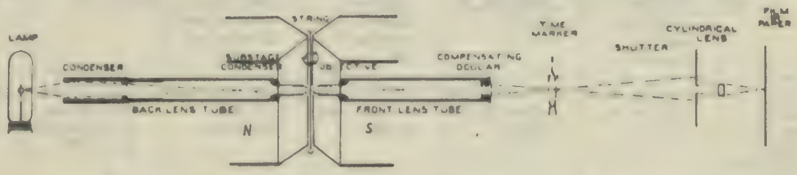
DESIGNED BY
DR. R.S.E. MURRAY

CORRELATION OF CARDIAC CYCLE AND ELECTROCARDIOGRAM

flow through the galvanometer for Lead II(2) is shown by the dotted arrow between the leg and right arm. The flow through the galvanometer for Lead III(3) is indicated by the arrow between the leg and left arm.

Additional precordial or chest leads provide specific information on myocardial conditions and in many instances are now taken routinely.

The string galvanometer was used exclusively till 1926 when the portable amplifier unit was introduced. The amplifier is a potential or voltage recording device while the string unit is necessarily a current recording instrument since the quartz string, which is gold plated to make it a conductor, is connected in series with the patient.



Schematic arrangement of string galvanometer electrocardiograph. The blocks N and S indicate the two pole shoes of the magnet. It is possible that the polarity might be reversed when the instrument is in use, but if it is as represented a current passing through the string from above downward would induce a magnetic field about the string in the direction of the small dotted arrows around the upper portion of the string. This would move the string backward away from the observer.

The amplifier picks up the minute heart voltages and amplifies them 800-900 times. Enough voltage is thus produced to operate a galvanometer which deflects a beam of light focused on a camera containing sensitive paper. The deflection of this beam of light writes the record. With the addition of millimeter ruling and time lines the record can be interpreted.

STANDARDIZATION - To make comparison possible it is necessary to establish standard conditions. The instruments are so calibrated that a 1 c.m. or 10 m.m. deflection occurs when 1 millivolt is impressed on the circuit. The units are checked to see that this condition exists prior to each test or tracing and in string units prior to each lead.

NOMENCLATURE - The shadow of the beam at rest is called the base line. The record of one complete cycle of heart contraction is an electrocardiogram.

Electrocardiograms are usually recorded on graph paper divided in horizontal and vertical directions into millimeters. Each horizontal millimeter is .04 second. Each vertical millimeter is .1 millivolt. Every fifth millimeter is marked by a heavier line.

The P. Wave is produced by auricular systole.

P-R interval represents the auriculo ventricular conduction time.

QRS complex represents the activation of the ventricles or intraventricular conduction time.

T wave represents the ventricular relaxation.

Table of characteristics of the Normal Electrocardiographic cycle from "Elements of Electrocardiographic Interpretation" (Katz & Johnson)

TABLE OF CHARACTERISTICS OF THE NORMAL ELECTROCARDIOGRAPHIC CYCLE

	P Wave	P–R Segment	QRS	S–T Segment (End of QRS to Beginning of T)	T Wave	T–P Segment (End of T to Beginning of P)
Direction Iso-electric level taken as beginning of P except when T and P fuse	Upward May be down or diphasic in III and rarely diphasic in I	Slightly Negative (after the P wave) May be iso-electric or slightly positive	Upward (in adults) May be down or polyphasic in III Down in I (in infants)	Iso-electric May be slightly positive when T is large and upright	Upward May be down, diphasic, or flat in III	Iso-electric May contain a low positive wave—the "U" wave
Contour	Rounded and Smooth May be peaked or slightly notched	Flat, Horizontal (after the P wave)	Sharply Peaked May be slurred or notched in III	Flat, Horizontal May slope upward when T is large and upright	Rounded or Peaked	Flat, Horizontal See above
Amplitude Horizontal lines are 1.0 mm. apart; equals 0.1 millivolt	1.0 to 2.0 Mm. May be less in III	2.0 Mm. or Less (after the P wave)	5.0 to 16.0 Mm. May be less in III	Iso-electric to 1.0 Mm. (positive)	1.0 to 5.0 Mm. May be less in III; usually ⅓ of QRS	Iso-electric to ("U" Wave) 1 Mm.
Duration Thin vertical lines are 0.04 seconds apart; thick lines 0.2 sec.	0.10 Seconds or Less	0.11 to 0.21 Seconds (Beginning of P to beginning of QRS; P–R interval)	0.10 Seconds or Less (Beginning of Q to end of S)	Not Significant May vary with heart-rate	0.01 to 0.20 Seconds	Varies Inversely with Heart-Rate
Corresponds to	Invasion of Auricles by cardiac impulse (activation of auricles)	Time Required for Transmission of cardiac impulse from sinus node to ventricles	Invasion of Ventricles by cardiac impulse (activation of ventricles)	Completely Activated State of Ventricles	Return of Ventricles to Inactivated Condition	Inactivated Condition of Ventricles
Lead IV Special features	Upward or Diphasic Notched or Smooth Amplitude Varies from minus 0.5 to plus 1.5 mm.	Iso-electric, usually	Diphasic with First Phase Upward May be slightly slurred. Ratio of first (positive) to second (negative) deflection varies between 0.3 and 1.5 Amplitude 8.0 to 40.0 mm., from top of first to bottom of second deflection	Positive to 2 mm. May be iso-electric Slopes Upward from S to T	Upward May be down in children Asymmetrical Ascending arm longer than descending Amplitude Zero to plus 8.0 mm.	U Wave Usually Present

ABNORMAL HEART RATES - Heart rates under 50 and over 90 are suspected of being subject to some pathological condition.

SIMPLE TACHYCARDIA - A heart rate greater than 90 when the P., Q.R.S., and T. complexes follow each other in constant normal relationship.

SINUS BRADYCARDIA - A heart rate less than 50 when the P., Q.R.S.. and T. complexes follow each other in constant normal relationship.

CHAPTER III

DIAGNOSTIC EQUIPMENT

SECTION 1-B

ELECTROCARDIOGRAPHS
- GENERAL ELECTRIC -

GENERAL ELECTRIC

GENERAL DESCRIPTION - The G-E Model B Electrocardiograph is completely self-contained, that is, it incorporates the integral parts of the amplifier, the control circuit and the power unit, and provides for the accommodation of accessory devices necessary for making an electrocardiographic tracing.

The electrical system consists of a specially designed three-stage vacuum tube amplifier which operates a reflecting galvanometer of suitable sensitivity and fast deflection time. The problems of patients' resistance, skin voltage, and overshooting due to capacity effects of the skin, are completely eliminated. This makes for accuracy and consistency in results and ease in manipulation. The galvanometer is of rugged construction and there is nothing in the routine operation of the electrocardiograph that can damage it.

The optical system is so constructed that a white tracing is produced on a medium black background. Both the millimeter and time lines are photographically recorded while the record is being made. The records are made on 45 mm. (1-3/4 inches) sensitized paper. The paper is supplied in 50-foot rolls.

A spring motor drives the paper and provides motive power for the time line device. A governor maintains a speed constant to within one per cent from the start to the finish of a 10-foot run of paper. Means are provided for quickly and accurately checking timing if and when this is found desirable.

The unit does not depend upon commercial power service for its operation. The power source consists of "A", "B", and "C" batteries. A battery test switch and a voltmeter for determining the voltage of the batteries are mounted on the control panel.

The patient's electrodes are of a corrosion-resisting alloy, and are used in conjunction with especially prepared electrode paste.

INSTALLATION The Electrocardiograph is shipped packed as a complete unit and is ready to operate after unpacking. After unpacking, but before destroying the packing material, check the following list of items which are provided as standard equipment:

- 1 Crank
- 3 Standard electrodes
- 3 Perforated rubber electrode bands
- 1 Precordial lead electrode
- 6 Cardiomounts
- 1 Roll of cardiopaper
- 2 Tubes of EKG electrode paste
- 1 Spare galvanometer lamp
- 1 Neon lamp.

DESCRIPTION OF CONTROLS - While the various controls and devices with which this instrument is equipped are either appropriately identified or their use is obvious, the following description and identification is presented to avoid any possibility of question as to function or manipulation.

MAIN SWITCH (4 and 7) - The main switch is of the tapered plug type which is the most satisfactory circuit-making device obtainable for this purpose. The position labeled "OFF" (7) is simply a receptacle for the tapered plug. To turn the instrument on, lift the tapered plug out of this receptacle and place in the one labeled "ON" (4) pushing it down as far as it will go readily and then turning slightly clockwise. This will wedge the plug into position and insure firm contact.

FILAMENT CONTROL (9) - This controls the voltage of the filaments of the amplifier tubes and of the standardizing circuit and should be so adjusted that the voltmeter needle (5) coincides with the calibration line marked "ON". As long as by adjustment of the filament control the voltmeter needle can be made to read to this position or higher, the "A" batteries may be assumed to be in satisfactory condition, but if with the filament control turned in a clockwise direction as far as it will go, the voltmeter needle does not come up to the "ON" position, the "A" battery should be replaced. When the voltmeter needle reads exactly on the calibration line, one millivolt is impressed across the circuit on standardization and correct calibration of the apparatus is assured.

VOLTMETER (5) - The voltmeter provides a means of assuring correct calibration of the instrument, and in conjunction with the battery switch (2) serves to check the voltage of the various batteries in the circuit. For checking the voltage of batteries, the voltmeter needle should read in the range marked "normal". This is explained in greater detail elsewhere in this text.

STANDARDIZING PUSH BUTTON (8) - In Electrocardiographic practice a calibration which causes a beam deflection of ten millimeters when a potential of one millivolt is impressed across the input terminals is accepted as standard. Pressing the standardizing push button momentarily, impresses one millivolt across the input terminals. The resultant beam deflection is readily observable in the observation window or sensitivity scale (12). The magnitude of the beam deflection when pressing the standardizing push button is readily increased or decreased by turning the sensitivity control (10) in appropriate directions.

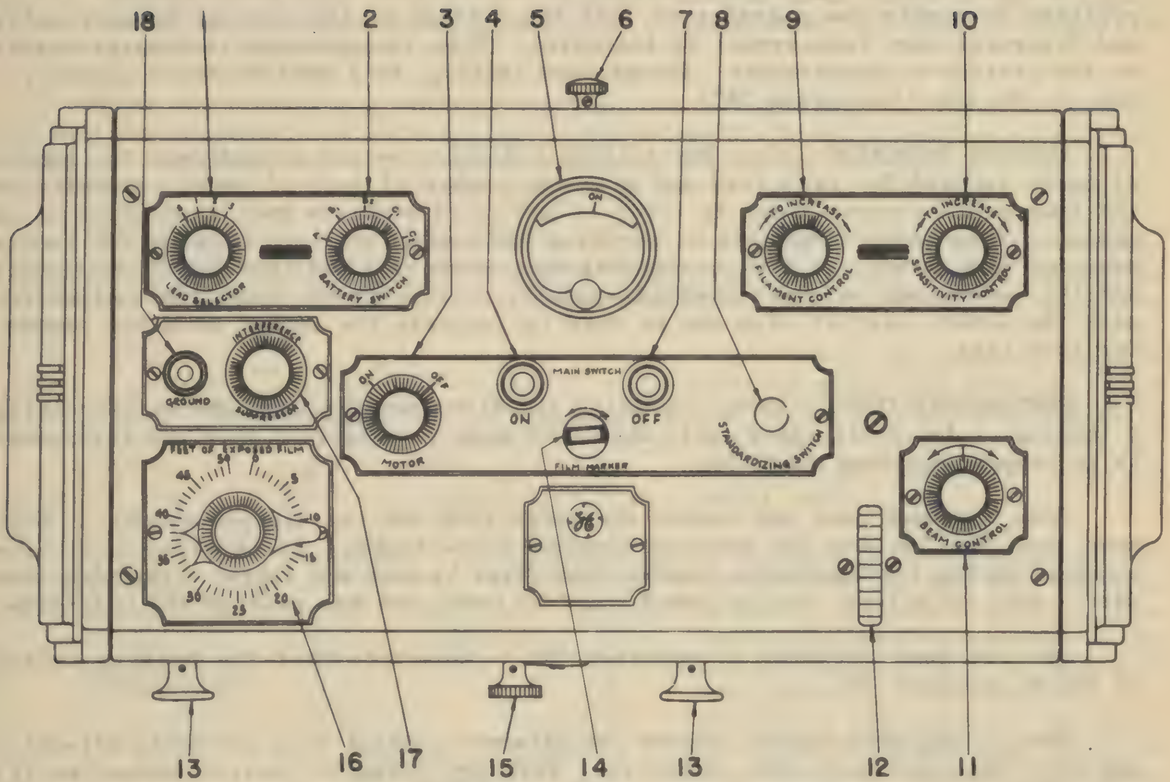
SENSITIVITY CONTROL (10) - This device determines the overall amplification of the instrument and ordinarily is adjusted to obtain a 10 mm. deflection. Lower or higher deflection can be readily obtained by turning the sensitivity control in appropriate directions.

LEAD SELECTOR (1) - While three electrodes are applied to the patient, only two are used in the recording of any one lead. The four positions in which the lead selector may be placed, designated as S, 1, 2, and 3 respectively, indicate standardization, lead 1 (right arm and left arm), lead 2 (right arm and left leg), and lead 3 (left arm and left leg). With the lead selector switch in position "S" the patient is disconnected from the Electrocardiograph, which permits calibrating or standardizing the instrument without the variations caused by heart action being registered. This results in greater accuracy and better appearance, both of which are desirable features.

OBSERVATION WINDOW (Sensitivity scale) (12) - After the light beam leaves the reflecting galvanometer,it is split by a mirror, a portion of the beam being directed onto the observation window (12) and the remainder into the camera. Thus is provided a visual indication of the beam action which is simultaneously being recorded on the photographic paper. The position of the beam as recorded on the photographic paper is identical with that observed in the observation window. Thus the operator has a continuous indication of the position of the beam on the paper and can change it at will to suit the circumstances.

The lines on the observation window are 5 mm. apart and provide a convenient means of determining beam excursions.

BEAM CONTROL (11) - The beam control is provided to permit the operator to properly orient the baseline with respect to the photographic paper. With some patients the beam excursion is predominately upward; in others it may be



View A

predominately downward, and in still others almost equally divided between upward and downward deflections. Thus, to produce the best appearing record, it may be desirable to shift the baseline closer to one edge of the record. This is accomplished by turning the beam control in the appropriate direction. Adjustment of the beam control has no effect on the accuracy or calibration of the record and may, if necessary, be manipulated while the tracing is being recorded.

MOTOR (3) - This is the control which starts or stops the driving and timing mechanism. The positions "ON" and "OFF" are plainly indicated.

FILM MARKER (14) - This device is provided to enable the operator to place a mark on the edge of the record to identify the various leads when such is deemed desirable. Momentarily turning this knob in the direction indicated causes a white mark to be registered on the edge of the record. To indicate lead one, turn the film marking lever once. To indicate lead two, turn it twice, etc.

INTERFERENCE SUPPRESSOR (17) - This device is provided to permit the operator to suppress or minimize the effects of interference picked up by the patient from A.C. power and lighting lines and ordinary appliances connected thereto. The ground wire is plugged into receptacle (18) only when recording heart action. It should be disconnected when instrument is stabilizing or when calibrating equipment.

BATTERY SWITCH (2) - This switch, in conjunction with the voltmeter (5) is provided to enable the operator to test the voltage of the various battery units and determine when replacement is indicated. This is explained in greater detail in the section on maintenance. Except when testing, this switch should always remain in the position marked "A".

FOOTAGE INDICATOR (16) - The footage indicator serves to indicate the amount of paper exposed for each lead and also the number of feet of paper remaining in the camera. The upper index is fixed to and turns with the knob when motor is in motion. This index indicates at any time the number of feet left in the camera provided that it was set at 0 on the dial when fresh roll was inserted in the camera and its setting was not disturbed subsequently by turning the knob. In conjunction with the lower index it also can be used to indicate the amount of paper exposed for each lead.

PRELIMINARY TESTS - After unpacking the Electrocardiograph and before taking a tracing, a few preliminary tests should be made to ascertain that the instrument is in proper operating condition.

Open the back door and remove the cover from the battery compartment. Make sure that the "A" and "B" battery terminals are tight. If terminal nuts have loosened during transportation tighten them first by hand and finish tightening them with a pair of pliers, but be careful not to break the wax seal on the batteries.

Set the lead selector on position "S". Ascertain that the battery switch is set on position "A".

Turn on the main switch, rotate the filament control in a clockwise direction and note the reading of the voltmeter. With the filament control turned as far as it will go, the voltmeter needle should pass the "ON" at least an eighth of an inch.

Adjust the filament control until the voltmeter needle reads exactly "ON". About one minute is required for stabilization. During this time, the beam does not remain stationary. When the unit is completely stabilized, the beam will remain stationary and can be brought to the center of the observation window by turning the beam control in the proper direction. In this position, it should remain perfectly motionless.

Turn off the main switch and turn the battery switch to each of the positions indicated. In each of these positions, the voltmeter should read within the range marked "normal".

Turn the motor on and off to make sure it runs. It is possible to stop the motor in a position in which one of the time marker blades intercepts the beam of light, thus giving an appearance of no beam in the observation window. If the beam cannot be located in the observation window, start and stop the motor.

Check the timing mechanism in the manner described in the section on maintenance.

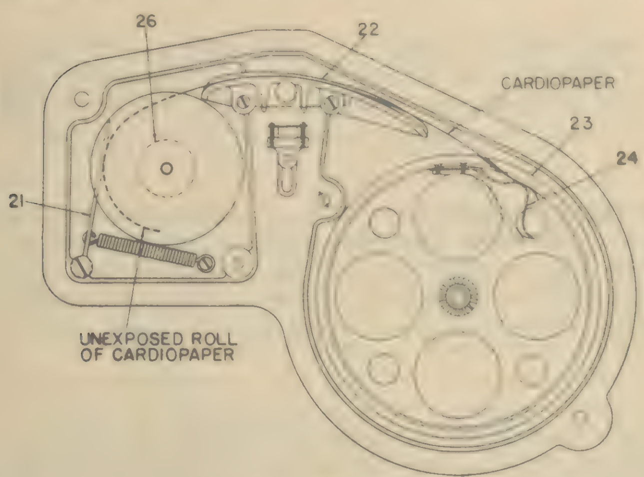
In making these tests, if results obtained are not as indicated, read carefully the section on maintenance. If this does not clear up any question, advise Medical Supply Services School Maintenance and Repair Branch at St. Louis, giving full details of the trouble experienced, and you will be advised as to proper procedure.

MAKING THE ELECTROCARDIOGRAM

LOADING THE CAMERA - Remove the camera from the Electrocardiograph by first unscrewing the chromium-plated thumbscrew (15) and then withdraw the camera by pulling out on the two knobs (13).

Place the camera on a bench or table in the darkroom with the three knobs down. A felt pad or other soft material may be placed on the bench to protect the finish. Unscrew the thumb nut in the lower center of the camera and lift the cover off. This exposes the entire working mechanism and allows the camera to be loaded.

The cardiopaper used is supplied in 50-foot rolls by all Army Medical Depots. It is coated on one side with photographic emulsion and will be ruined if exposed to light; open only in the darkroom. Do not remove the cardboard core on which the paper is wound.



VIEW B

Remove the wrapping from the roll of paper and free the start end which is stuck to the roll. Push the friction lever (21) out of the way, and lift out the spool (26).

Insert the spindle of the spool into the new roll of cardiopaper, making certain that when facing the disk side of the spool, the cardiopaper unwinds upward on the left side, so that when replaced in the camera, the paper strip may be passed over the slide (22) with the emulsion side toward the slide.

Press the spring clip (24) in the receiving spool (23) with a finger and pull the end of the paper under it as illustrated in View B.

Now rewind the cardiopaper on the unexposed roll by turning the roll backwards as far as it will go without pulling it out of the spring clip in the receiving spool. This will bring the slot in the receiving spool as close as possible to the end of the slide and will hold the paper taut across the slide. The camera case may now be replaced.

The camera case is secured to the camera proper by means of a single thumb nut and is designed to permit easy assembly. It is suggested that before loading, the camera be examined in daylight by everyone who is to use it so that they may be familiar with its construction. This will greatly facilitate manipulation in the darkroom.

When replacing the camera in the Electrocardiograph, do not force. It is possible for the position of the gear teeth which constitute the coupling mechanism in the camera and in the motor assembly to fail to mesh, in which case, the camera cannot be readily inserted.

DO NOT FORCE the camera into position. If it does not go into place readily, start and stop the motor which will change the relation of the two halves of the coupling gear and permit the camera to be easily inserted. If the camera is jammed into position it may lock the motor. Under this condition a tracing cannot be made.

After replacing the camera, tighten the thumbscrew (15). Start the motor and allow it to run for approximately 2 seconds before turning on the main switch.

WINDING THE MOTOR - Insert the crank for winding the motor in the hole provided for it in the rear panel. Turn the crank in a counterclockwise direction (when facing the rear panel) and continue winding until the crank is stopped. Do not force beyond this point. The crank should be removed when operating the motor.

Although the motor is designed to drive at least 30 feet of cardiopaper without rewinding and without introducing appreciable inaccuracies, it should be rewound at least every 20 feet of paper run or equivalent motor operation. By following this practice, any possibility of the motor running down while making a tracing will be eliminated.

Not more than 20 feet of paper should be run onto the receiving spool. More than 20 feet may cause difficulty by forcing too much paper on to the receiving spool. If a 14 x 17 x-ray film hanger is used for developing, the paper should be removed every 15 to 18 feet. More than this cannot conveniently be placed on this hanger.

PREPARATION OF THE PATIENT FOR TAKING A TRACING - A good electrocardiogram from a technical standpoint should be free from the effects of somatic tremor. Somatic tremor causes deflections to be superimposed on the heart tracing and thus detracts from the appearance and diagnostic value of the record. Somatic tremor can be eliminated in a majority of cases if proper precautions are followed before taking the tracing.

The patient should be allowed to rest comfortably in a sitting or lying position. It is important that the patient shall be comfortable. If the patient appears apprehensive or is distracted by noise, the tracing is likely to be distorted. The patient must be assured that no shocking sensation or unpleasant experience of any sort will result from the examination and must be thoroughly relaxed and fully at ease.

TURNING ON THE APPARATUS - In order that the instrument may reach stable condition, the main switch should be turned on at least three minutes before the tracing is taken. This allows ample time for connecting the electrodes and positioning the patient.

Be sure that the lead selector is on position "S" and the battery switch is on position "A". Lift the main switch plug from the "OFF" receptacle, insert it to the "ON" receptacle and wedge it in place by turning it clockwise. Adjust the filament control slightly to the right of the "ON" mark on the voltmeter.

By the time the patient is connected and the three minute period has elapsed, readjust the filament control if necessary so that the voltmeter needle is exactly on the "ON" line. As soon as the beam "stabilizes" or becomes stationary on the calibration scale, the instrument is ready for calibration.

The calibration scale as seen in the observation window should be illuminated as soon as the main switch is turned on. If it is not, it is because one of the blades of the timer has stopped in a position in which it intercepts the beam of light. To correct this condition start and stop the motor. If this does not correct condition open back door and note if galvanometer bulb is lighted. If bulb does not light it is probably burned out and should be replaced. Consult maintenance section for bulb replacement.

CONNECTING THE PATIENT - The patient's electrodes, rubber electrode bands, connecting cable, and electrode paste are kept in the drawer in the base of the machine. The electrodes, bands and paste should be removed and the connecting cable brought out through the slot in the center of the drawer. This permits the drawer to be kept closed while the record is being made. The electrodes are readily disconnected from the cable and thus may be applied more easily to the patient. To prepare the electrodes, attach the perforated rubber bands to the two hooked prongs of each electrode.

The electrodes are to be applied to a flat portion on the inside of the right and left forearms and calf of the left leg. Select an area that conforms to the contour of the electrodes as nearly as possible, so that good contact over the entire electrode area may be secured.

Apply a small amount of paste (about 3/4 inch) from the tube to the skin area selected. Rub the paste vigorously into the skin for 5 to 10 seconds, covering an area slightly larger than that of the electrode.

Apply an additional quantity of paste (about 1/2 inch) and spread evenly over the rubbed area. Fasten the electrode with the perforated elastic strap, firmly but not too tightly. If the band is pulled too tightly, the muscles will become constricted and prevent complete relaxation which is essential if a good record is to be obtained. On the other hand, if the electrodes are bound too loosely, poor contact may result with a consequent uneven baseline on the tracing.

Connect the lead wires of the patient's cord to the proper electrodes, following the markings on the patient's cable terminals. Fasten the thumbscrews securely.

The electrocardiogram may be made with the patient either in a sitting or reclining position. The patient's hands should not touch each other and the legs should not be crossed. The arms and legs should not be excessively flexed or complete relaxation cannot be obtained. If the patient is wearing clothing which is tight, better results may be obtained if it is loosened. Care must also be exercised that no constriction of extremities occurs when the patient's clothing is rolled up for the application of electrodes.

STANDARDIZING - If the main switch was turned on before the electrodes were applied, the apparatus should be stabilized by the time application of the electrodes is completed. If this is true, the beam should appear stationary in the observation window, and the instrument is ready for calibration or standardization.

If the calibration scale is not illuminated the beam cannot be seen. In this event start and stop the motor which should cause the scale to become illuminated. If with the scale illuminated the beam cannot be seen turn the beam control until the beam comes into view.

Manipulate the beam control so that the near edge of the beam is made to coincide with the first line on the far side of the center position of the calibration scale in the observation window. Press momentarily the standardizing push button. This action impresses one millivolt on the input side of the amplifier and causes the beam to deflect toward the operator. Adjust the sensitivity control so that when the standardizing button is pressed a beam defection of two divisions on the scale, which represents 10 mm., is obtained. The beam excursion should be measured from near edge to near edge

When the sensitivity control is moved, the beam will change its position, and should be corrected by means of the beam control.

With the instrument thus properly standardized, a record of standardization should be made as follows:

Start the motor and allow to run for approximately two seconds.
Press momentarily the standardizing push button.
Allow the motor to run for approximately one second and turn off.

This will produce a standardization record approximately 3 inches long, containing one excursion of the beam which, if standardization adjustment has been properly made, should show a deflection of exactly 10 mm. If desired, two, three or more standardization marks may be recorded.

If through error the instrument has not been properly standardized to produce a 10 mm. deflection when the standardizing push button is pressed, no inaccuracy in tracing will result, it being only necessary to remember that the excursion as registered on standardization regardless of what this may measure, is the excursion produced by a potential of one millivolt, and correction may be made accordingly. For instance, if the standardization mark is 11 mm. instead of 10, it is 10% too high and all waves in the record will be exactly 10% too high. Correction can thus be made.

TAKING A TRACING - Standardization having been completed, change the lead selector to position 1. This connects the right arm and left arm of the patient to the instrument. After changing the position of the selector switch, the beam may wander over the calibration scale, but should settle down in most cases within a short time (approximately 10 seconds). The excursions of the beam produced by heart action will be seen in the observation window.

As soon as the beam has settled down, manipulate the beam control to center the beam excursions so that the excursion in either direction is approximately the same distance from each edge of the observation window. While this adjustment in no way affects accuracy, a much neater appearing record will be obtained if the tracing is properly centered.

Turn by means of resettable arm the lower index until it coincides with the upper index. Start the motor and allow it to run until the required amount of paper has been exposed for the first lead. One foot of paper is usually all that is required for a single lead. This corresponds to the upper index travel over one division on the scale. After the upper index has traveled a distance equivalent to one division on the scale from the lower index turn off the motor. Repeat the procedure for the second and the following leads.

Repeat this procedure with the selector switch on position 2 and position 3, allowing a short time after each change in lead selector switch position for the beam to stabilize. Lead 2 connects the right arm and left leg of the patient, while lead 3 connects the left leg and left arm.

Occasionally a patient is encountered who causes the beam to move slowly back and forth. In such a case free use of the beam control should be exercised to hold the beam on the calibration scale.

IDENTIFICATION OF LEAD - The lead marker is provided for identification of the different leads. Three or four seconds after the motor is started for taking the first lead, turn the lead marker knob momentarily counterclockwise. This will produce a white mark along the bottom edge of the paper. To mark lead 2, turn the lead marker twice in succession. Similarly, lead 3 is marked by turning the

lead marker three times in succession. If it is desired to secure the identifying marks throughout the length of the tracing, actuate the lead marker the corresponding number of times at intervals as long as the motor is running. This will result in a series of white marks along the bottom of the record.

RECORDING TRACINGS OF SEVERAL PATIENTS - Electrocardiograms of several patients may be taken without developing a record for each one. To eliminate the possibility of error, it is suggested that a record of the patient's names or numbers be made in the order taken. If desired, a standardization mark can be used for further identification. When this method is used, standardize once for the first patient, twice for the second patient, three times for the third patient, etc. Bear in mind, however, that the camera should be rewound every 20 feet of paper run, or equivalent motor operation, and not more than 20 feet of paper should be run into the receiving chamber without unloading. A 10 foot run of paper is ample for six patients, if individual leads not longer than approximately 12 inches are made.

DISCONNECTING THE PATIENT - On completion of the tracing, place the main switch in the "OFF" position and change the lead selector switch to position "S". To insure that all of the exposed parts of the paper are beyond the point where it will be cut off, run the motor for approximately two seconds after the last tracing has been completed.

Disconnect the patient's leads by loosening the thumbscrews and removing the leads. Remove the electrodes and wipe the patient's arms with a damp cloth. Rinse electrodes and rubber bands in warm running water and allow to dry.

RECORDING PRECORDIAL LEADS - Precordial lead technic in electrocardiography has become so increasingly important in the past few years that it has been deemed advisable to include the new G-E precordial electrode with the instrument. The recommendations of the committee of the American Heart Association for the Standardization of Precordial Leads were followed in designing this electrode.

The precordial electrode can be used in either of two ways. It can be held by means of the insulated handle, or the handle may be unscrewed and the electrode held by hand. In the latter case, it is recommended to interpose a piece of cloth folded into two or three thicknesses between the electrode and the hand. If desired, a small sand bag may be used instead of the hand for holding the electrode in place provided the patient is in a reclining position.

Electrode paste should be applied to the chosen area in the precordial region in the usual manner. Either the patient or the operator can hold the electrode in place.

Although the Committee describes several single and multiple precordial lead methods, the lead IV F is suggested as preferable for all ordinary purposes. After completion of recording the lead III, the unit is left turned on. The cord wire stamped L.L. is changed to the precordial electrode and the cord wire stamped L.A. is connected to the electrode which has been attached to the left leg. After the beam is fully stabilized, as observed in the calibration window, the lead IV F is taken with the lead selector on position 3. Although the lead connected to the right arm is not in the circuit, it is preferable to leave it connected during the recording of precordial lead.

For method of recording other single and multiple precordial leads, consult the reprint "Standardization of Precordial Leads" which is supplied with the instrument.

DEVELOPING THE TRACING - Cardiopaper should be developed in the same manner as ordinary x-ray or photographic film. If an x-ray darkroom is available. the regular x-ray developer may be used. Short strips of film can be developed in trays. Long strips should be developed in tanks similar to the manner in which x-ray film is handled. Approximately 15 feet of paper can be wrapped around a 14 x 17 x-ray film developing hanger. When this method is used, be certain the paper is wound around the hanger with the emulsion side out.

Standard development calls for five minute development time, with the developer at a temperature of 65 degrees Fahrenheit. Follow the x-ray film time temperature chart for developing the cardiopaper at other developing solution temperatures. To produce a permanent record, the paper should be fixed for approximately double the time of development and then washed for at least 15 minutes in running water. If lighter records are preferred, cut the development time short; on the other hand, prolong the development if darker records are desired.

Ferrotyping of the record provides a hard glossy surface and prevents the record from curling. In addition, the clarity of the record is improved. Chromium-plated ferrotype plates are especially recommended.

To ferrotype the record first clean the ferrotype plate with warm water. Take the developed and washed record out of the wash water and lay it emulsion side down on the ferrotype plate. Now press the record firmly against the plate with a rubber squeegee roller. Excess water is easily removed with blotting paper.

If the facilities of an x-ray or photographic darkroom are not available the records can easily be developed by the tray method provided the length of the record is short such as that of a single patient. Longer records require a tank and a larger quantity of chemicals for convenience in handling. The emulsion is fast, hence the camera should be opened and the paper developed only under a safe dark-room light.

If a complete record of only one patient is removed from the camera and developed, it will consist of a strip of cardiopaper approximately 3½ feet long. (The exact length will depend upon how long the operator allowed the motor to run.) When looking at the emulsion side, the standardization mark should be at the left and directed upwards. Leads 1, 2, and 3, follow in order, each identified by a series of white marks on the bottom of the tracing, provided, of course, that the operator has properly manipulated the lead marker. Should several records be made before developing, the standardization marks which always precede the actual heart record serve to separate the individual records. If a record of the patient's name or number is kept in the order in which his record was taken, them the developed cardiopaper containing several records can be laid out so that with the standardization marks to the left and leads 1, 2, and 3, following, the individual records occur consecutively and in the order in which the patients' names or numbers were recorded.

INTERFERENCE - In the operation of the Electrocardiograph, deviations of the recording, evidently not of patient origin, may be experienced. These deviations make electrocardiograms less valuable as a means of diagnosis, and if present to an appreciable degree, may render them useless.

It must be remembered that the Electrocardiograph is a very sensitive precision instrument, capable of recording faithfully very slight changes in the heart potential. The electrocardiograph may also respond to the effect of external influences if brought close enough to the interfering source. Electromagnetic and electrostatic induction are the most common causes of interference.

Electromagnetic interference is produced through a magnetic phenomenon which is associated with the current actually flowing in a nearby electrical circuit. Electrostatic interference, on the other hand, occurs regardless of current flow. This may originate from a circuit, one side of which is disconnected from the supply source or which carries no load.

Interference may be recognized by observation of the beam on the calibration scale and is readily seen if it appears on the developed tracing.

With the lead selector on position "S" closely observe the width of the beam on the calibration scale. Move the selector to other lead positions and as soon as stabilization of the apparatus is completed, note if the width of the beam has increased. This widening of the beam if present is caused by deflections so rapid that the eye cannot distinguish each separate movement. If these deflections are not too large, deviations of the beam due to heart action will still show.

With the selector switch on position "S" the patient and patient's cable is disconnected. The complete shielding of the amplifier unit prevents interference from being picked up, except where the instrument is used under the influence of an unusually powerful interfering field. If a tracing is made under this condition, complete distortion of the heart record will surely result.

Interference can be detected more definitely by examining the finished tracing. Interference resulting from alternating current power service appears as a smooth regularly-recurring oscillatory wave form superimposed upon the heart record. The wave form is characterized by constancy of frequency and uniform height of the resulting oscillation.

INTERFERENCE SUPPRESSOR - The interference suppressor is designed to neutralize completely or reduce to a minimum low frequency interference from lighting and power circuits which may be picked up by the patient and cause distortion of the tracing.

The suppressor consists of control and plug receptacle arranged to receive the plug on end of the ground wire. On the instrument end of the ground wire is a connecting plug and the grounding end of the wire is supplied with a metal clamp permitting easy attachment to the ground.

Three methods of using ground wire are listed below in order of preference:

1. Hold the metal clamp in bare hand throughout taking a tracing except when recording standardization mark.
2. Lay the ground wire on the floor if no water pipe is in immediate vicinity.
3. Connect ground wire to a good water pipe ground.

When standardizing with the lead selector on position "S", the ground wire plug should be removed from the plug receptacle on the instrument control panel. Leaving the ground wire connected to the instrument will very likely result in pickup of interference if it is present.

After standardization procedure is completed, turn the lead selector to position "I". Presence of interference can be identified by observation of the beam on the calibration scale. If the beam widens, becomes less opaque and the edges of the beam are fuzzy, interference is picked up by the patient.

Effective elimination or reduction of interference can be attained by connecting the ground wire to the instrument and trying the methods of using the ground wire as suggested above, and then turning the suppressor knob through a medium point until the beam is opaque, clear cut and is of minimum width. The record should then be made without leaning or resting hands on, and touching the metal parts of the instrument. Various control knobs are made of insulated material and can therefore be handled in normal manipulation of the instrument without feeding interference from the operator into the unit.

Follow same procedure when recording other patient's leads.

SOMATIC TREMOR - Somatic tremor causes deflections and is frequently mistaken for electrical interference, yet is easy to distinguish for it lacks the uniformity and regularity of wave shape characteristic of alternating current interference. Waves caused by somatic tremor are irregularly spaced, usually of variable height and are of various shapes.

Interference resulting from the operation of mechanically rectified x-ray apparatus or high frequency equipment resembles somatic tremor in some respects, but if the interfering source is strong, may be of greater magnitude, and is usually characterized by extreme irregularity of wave form.

SKIN-ELECTRODE CONTACT - Poor skin-electrode contact resulting from insufficient massaging of the skin under the electrode with the paste or loose binding of the electrodes is very apt to increase interference pickup. Therefore, make certain first that good skin-electrode contact is secured. If interference is still present to an objectionable degree follow other steps described below.

LOCATION OF INTERFERING SOURCE - The interfering source can be located through the process of elimination. Light switches in the room should first be turned off, and extension cords and other electrical devices plugged into outlets should be removed from the receptacle. Electrocardiographs should be kept away from walls in which electrical wiring may be concealed and should be tested in different positions in the room.

If turning off the source of interference is not possible, the apparatus must be moved away from the source. Move the apparatus and patient to a different location in the same room or to a different room until a location is found that no longer causes interference.

SHIELDING - In extreme cases where interference cannot be suppressed or eliminated by the above means, shielding of the patient, apparatus, and operator, will offer protection against interference. The shield may be constructed by erecting a light framework of wood and covering it on all four sides top and bottom with 16 mesh galvanized iron wire screening. The shielding booth should not be placed adjacent to x-ray or high frequency equipment. The General Electric X-Ray Corporation has available complete plans and construction data for building booths of two different sizes. The smaller one accommodates the patient in a sitting position only, while the larger will accommodate a couch on which the patient may lie down.

INSTRUCTIONS FOR MAINTENANCE OF THE MODEL B ELECTROCARDIOGRAPH

The electrocardiograph is designed to permit quick and simple servicing. Testing and replacing batteries, replacing the galvanometer lamp, checking and adjusting motor speed, etc., can easily be cared for by the user.

Other servicing, such as replacement of the amplifying tubes or resistor-capacitor pack should preferably be rendered by the General Electric X-Ray Corporation service organization. However, should these services for some reason be unavailable, a capable electrician or radio man should be able to do the work satisfactorily.

As a general rule, any servicing of a nature not covered in these instructions should be handled only by a representative of the General Electric X-Ray organization.

To assist in a diagnosis of the trouble, a sample tracing of all patient leads and of the standardization lead made, preferably on a patient whose heart tracing is normal should be submitted together with a detailed description of the trouble experienced. Just as the Electrocardiographic tracing will usually tell the physician more about the condition of the patient's heart than the patient can tell, so does the tracing often tell more about the condition of the instrument than can possibly be told in words.

BATTERY MAINTENANCE

TESTING THE BATTERIES - The voltage of the batteries used in this unit can be readily checked by means of the battery test switch. The voltage for each group of batteries is indicated by the reading of the voltmeter on the control panel.

To test the "A" battery, turn the main switch on, then turn the filament control in a clockwise direction as far as it will go. The voltmeter should pass the "on" position and read within the range marked "normal". If it does not reach the "on" position, replacement should be made.

For testing the other battery units, turn the battery test switch to the corresponding position. In each case the voltmeter should read in the range marked "normal". If on any position the voltmeter does not read within this range, the particular battery indicated by the position of the battery switch requires replacement, as indicated in the section following.

Although this test indicates accurately the voltage of the batteries, it is not necessarily an indication of their internal condition. Occasionally, batteries may be the cause of erratic beam behavior even though the voltage readings are normal. Replacement of the suspected batteries with new ones will quickly prove whether this is the case. First replace the "B" batteries and note if the beam is steady on the calibration scale. If trouble continues, replace the "A" batteries and finally the "C" batteries.

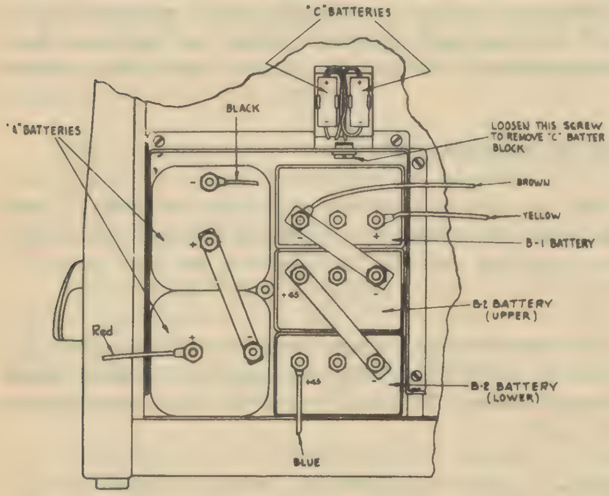
The battery test switch should always be left on position "A" except when testing batteries. If left on other positions, it will cause batteries to run down.

REPLACEMENT OF BATTERIES - The frequency at which batteries will require replacement depends upon the amount of service to which the unit is put. The average life of the "A" batteries is about 20 hours actual operating time. "B" batteries will normally require replacement every four to six months, oftener if the equipment is used frequently and less often if the equipment is used only occasionally. The "C" batteries should normally last approximately twelve months, regardless of the amount of service to which the equipment is placed.

Attention is called to the fact that dry cell batteries deteriorate even when not in use. Their life is a function of climatic conditions, age and current drain.

Thus renewals may be required after a reasonable period of time even though the apparatus was used infrequently or not at all. The date stamped on batteries is the expiration date which is usually one year in advance of the date of manufacture except for #W30BPX "B" battery the expiration date of which is only six months.

The power unit containing the batteries is located in the lower left hand corner when facing the instrument from the rear. To gain access to the batteries, loosen the single thumbscrew in the center of the hinged door and swing the door open. Now loosen the thumbscrew in the center of the power unit cover and remove the cover. This exposes the batteries and permits their replacement.



VIEW C

The various batteries are readily identified by referring to View C. Two "A" batteries are required. They are identical and are connected in series by means of a metal link. Notice the polarity marking on the batteries. Remove the four nuts from the old batteries. Replace the batteries with new ones in the same relative position.

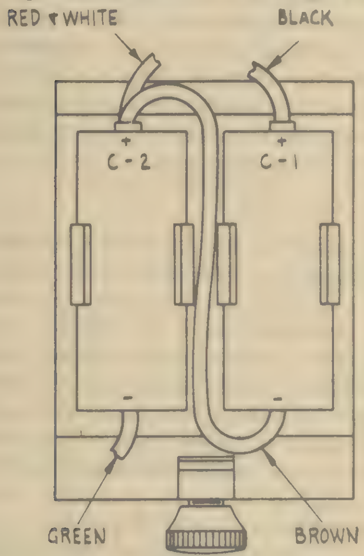
Connect the black lead to the negative terminal of the upper battery. Connect the metal link to the positive terminal on the upper battery and to the negative terminal on the lower battery. Connect the red lead to the positive terminal of the lower battery. Screw the four terminal nuts on tightly with a pair of pliers but be careful not to turn the nuts tight enough to break the wax seal on the battery. Loose connections at the terminals of these batteries will cause the beam to be erratic.

The various batteries identified in View C, correspond with the markings on the battery switch. When the battery switch is placed on position B-1, the voltmeter indicates the voltage of the B-1 battery. On position B-2, the voltmeter reads the combined voltage of the two "B" batteries connected in series. If B-1 battery is low, it should be changed. If the combined voltage of the two B-2 batteries with the battery switch on position B-2 is below normal, change batteries.

The B-2 batteries are connected in series by means of a long metal link. Loosen the nuts, remove the connections, and replace with a new set. Place the metal link on the positive 45 volt terminal of the upper B-2 battery and the negative terminal of the lower B-2 battery. Connect the yellow lead to the positive 45 volt terminal of the B-1 battery. Connect brown lead to the negative terminal of the B-1 battery. Connect the blue lead to the positive terminal of the lower B-2 battery. Connect negative terminals of B-1 and upper B-2 batteries by means of a short metal link. Tighten the nuts firmly with pliers but use care not to break the seal.

The "C" batteries are held in position by clips mounted on the terminal board immediately above the battery compartment. To remove the "C" battery block, loosen the thumb nut from under the top of the battery compartment and slide out the complete unit. The cells may be readily identified by referring to View D.

IMPORTANT: Care should be exercised not to allow the "C" batteries to come in contact with the terminals of the "B" batteries. It is recommended to place an empty cardboard box next to the "B" batteries and set the "C" battery block on top of the box. This will eliminate the possibility of accidental dropping of the "C" battery unit and burning out of the filaments of the galvanometer lamp and amplifying tubes due to application of the "B" batteries voltage on the filaments.



VIEW D

Whenever one of the "C" battery cells requires replacement, the other cell should preferably be replaced. These cells are inexpensive and easily changed and to replace the entire group at the same time is good insurance against the probability of any difficulty from the "C" batteries for many months. In soldering the leads to the "C" cells, care must be exercised not to damage the cell or melt the zinc container.

In soldering the leads to the "C" cells, use a hot iron and rosin core solder, making connections exactly as shown in View D.

All batteries furnished with the Electrocardiograph are manufactured by the Burgess Battery Company. In ordering replacements, it is recommended that Burgess batteries be specified, according to the table below:

SPECIFICATIONS FOR BATTERY REPLACEMENTS

If purchased locally:

Quantity	Description
2	Burgess Little Six #4FH dry cells
2	Burgess #4 Unicells
1	Burgess #20F2 Battery

#Z30N "B" batteries available locally may not be suitable.

If purchased from G.E. X-Ray Corporation:

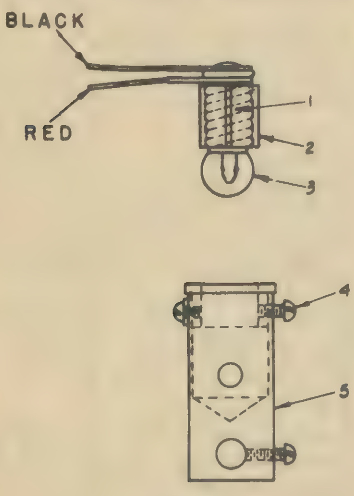
Quantity	Description
1	Cat. P7009B set of two "A" batteries for Electrocardiograph
1	Cat. P7007E "B" battery for Electrocardiograph (three batteries are required)
1	Cat. P7015B set of two "C" batteries for Electrocardiograph

If ordering by wire from the General Electric X-Ray Corporation, the following code words may be substituted for catalog numbers and descriptions given above:

Code Word	Denotes
PEBOS	Cat. P7009B
PETSO	Cat. P7007C
PEMED	Cat. P7015B

REPLACEMENT OF GALVANOMETER LAMP - The galvanometer lamp which is the source of the illumination for the optical system, is a special lamp not interchangeable with the standard 2.4 volt lamps available on the market. The life of this lamp, as of any other incandescent lamp, is indefinite and occasional replacement will be required. Lamp replacement may at times be required because it has become darkened thus cutting down light intensity. Under these circumstances the intensity of light on the sensitivity scale will be reduced and the records will require longer developing time. A spare lamp has been provided with the Electrocardiograph. Additional lamps should be secured from the General Electric X-Ray Corporation.

Lamp replacement may be effected in a few minutes' time. The lamp is housed in a small black cylinder (5) located in the center of the back compartment near the bottom. To remove the lamp, loosen set screw (4) on the upper right hand side of the lamp housing. The lamp and socket can now be readily lifted out. Be careful not to disturb the lamp housing when removing the lamp, and do not loosen any other screws in the housing. The lamp housing was in perfect adjustment when the instrument left the factory and the galvanometer lamp replacement if carefully done will require no further adjustment.



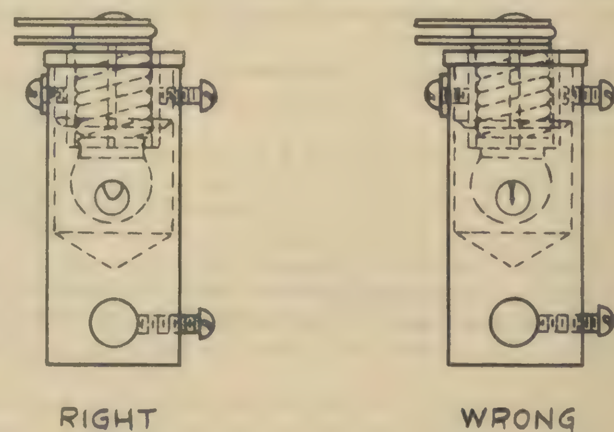
VIEW E

Before replacing the lamp, slip the split metal bushing (2) over the screw shell (1) of the lamp socket. Screw the lamp (3) firmly into the socket. Poor contact in the socket will cause an unsteady beam and result in unsatisfactory operation of the electrocardiograph. After screwing the lamp firmly into position, wipe cith a clean cloth to remove fingerprints from the lamp.

Before replacing the lamp, note that the filament consists of a V-shaped loop of wire. Insert the lamp in the socket in such a manner that the plane of the filament is parallel to the long axis of the Electrocardiograph, that is, so that when facing the lamp from the rear, the full "V" is seen rather than a side view as shown in View F. Slip the socket with the lamp into its housing and tighten the set screw (4) lightly so that the socket retains its position and at the same time is loose enough to be moved about for final adjustment.

Now remove the camera. With a piece of white paper, cover the inclined mirror furthest from the galvanometer. This will enable you to see the distribution of light when positioning the galvanometer lamp in its housing.

Move the lamp up and down in its housing until the light as observed on the piece of white paper over the area of the mirror and on the calibration scale is of



VIEW F

maximum intensity and is evenly distributed. For this adjustment the beam control should be placed in the central position so that the beam is in the center of the calibration scale. If this movement of the lamp does not suffice to give satisfactory illumination on both the paper over the mirror, and on the calibration scale rotate the lamp in its housing or swing it on its support if necessary. When properly adjusted there will be no color in the illuminated field as observed on both the paper over the mirror, and on the calibration scale, except near the edges where the light ends. As a final check expose and develop a short strip of cardiopaper. The developed tracing should be of uniform and satisfactory density.

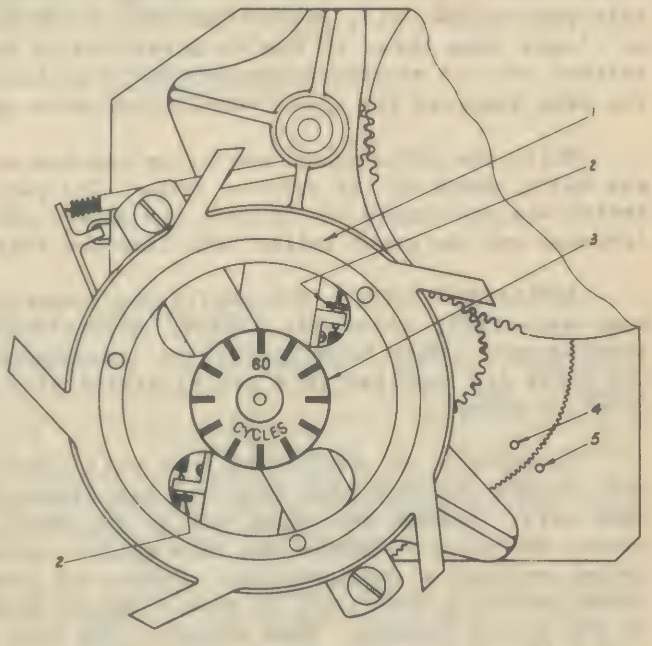
TIMING THE MOTOR - The spring motor used to drive the paper and to provide motive power for the time line mechanism is ruggedly built and is initially adjusted to within a fraction of one per cent accuracy. It should remain in adjustment over long periods of time.

Means is provided for quickly and easily checking the accuracy of motor speed and correcting it when necessary. The provision for means of checking and adjusting does not in any way imply that the mechanism has a tendency to run inaccurately. As with all precision instruments which are periodically checked, this provision for checking timing accuracy has been provided so that accuracy can be proved, not taken for granted.

Two methods of checking timing accuracy are provided, both simple and accurate. Where alternating current of a uniform frequency, divisible by five (or some other small denominator) is available, the stroboscopic method is recommended. Where suitable alternating current is not available, timing may be checked by means of a stop watch (or an ordinary watch with a second hand if a stop watch is not available) using an index mark provided for that purpose. Whenever checking timing, it is essential that the camera be loaded and in position since the purpose of checking timing is to determine the rate at which the cardiopaper is being passed through the camera - not the rate at which the motor moves without this load. The main switch should not be turned on.

The stroboscopic method of testing requires the use of a small Neon glow lamp supplied with the equipment. This lamp should be screwed into an ordinary electric light extension cord which is then connected to the line. The Neon Lamp supplied with the equipment is designed for use on 115 volt electric service.

Unless frequency is specified at the time the order is placed. the Electrocardiograph will be supplied with a 60 cycle stroboscopic disk. Where alternating current of some other suitable frequency is available for checking purposes, a stroboscopic disk made specifically for that frequency can be supplied. It is important that the frequency of the electric service be exactly



VIEW G

the same as the frequency marked on the stroboscopic disk. Unless this exact relationship exists, checking by the stroboscopic method will be in error, and the stop-watch method therefore is preferable. Be sure the motor is properly wound before starting the time check.

THE STROBOSCOPIC METHOD - Open the rear panel to the Electrocardiograph and observe that the frequency stamped on the stroboscopic disk (see View G) corresponds to the frequency of the alternating current available. The bars on the stroboscopic disk are quite conspicuous when the disk is stationary but are indistinguishable when in motion and viewed by ordinary light. If the disk is illuminated by means of the Neon glow lamp, the bars on the disk will appear to stand still or move very slowly in one direction or the other. When the motor speed is correctly adjusted, the bars will remain stationary. They may drift slightly forward and then backward, but their relative position will remain unchanged.

If the bars appear to move clockwise, the timer is running fast. If they appear to move counterclockwise, the timer is running slow.

To change the motor speed, turn the timing disk (1) to approximately the position shown in View G. Turn the upper knurled nut (2) to the right to slow down the motor or to the left to speed up the motor. Now turn the timing disk (1) 1/2 revolution so that the lower knurled nut (2) is brought into approximately the same position as the nut just adjusted. Turn this second nut in the same direction and the same number of turns as was made on the first nut. Be sure that whenever adjustment is made to motor speed, the adjustment is made equally on both of the knurled nuts (2).

THE STOP-WATCH METHOD - The stop watch method involves only the measuring of the time required for the marked gear (below and to the right of the timing disk) to make nine revolutions. An index mark (4) is placed on this gear and another mark (5) adjacent thereto on the frame for convenience in noting the number of revolutions. If the motor is running at the proper speed, the time required for this gear to make nine revolutions will be 2½ minutes. If the motor speed is faster or slower than this, it can be corrected by adjusting the knurled nut (2) as described for the stroboscopic method. A preliminary check can be made by measuring the time required for three revolutions which should be 50 seconds.

While the motor speed was being checked and adjusted, the paper in the camera was being wound on the take-up drum. The paper was not exposed because the main switch was not turned on. To save the paper, the camera should now be removed to the darkroom and the paper rolled back from the take-up drum on to the fresh roll spool.

AMPLIFYING TUBES - The amplifying tubes used in the Electrocardiograph have been especially selected, tested, and matched in sets for use in this Electrocardiograph. When tube trouble is experienced, the entire set must be replaced The tubes are supplied in a sealed carton with leads of proper length and properly coded in color.

To replace the amplifying tube unit, remove the metal guard held by means of four screws and unsolder from the two terminal boards the leads coming from the tube unit. Loosen the thumb nut on the metal case containing the tube unit and remove the cover. Remove the tube carton containing the old tubes and insert the carton containing the new tubes. Solder the leads from the new unit to the terminal boards matching the colors on each terminal with those remaining connected as shown in the wiring diagram. When ordering the tube unit, specify Cat. P7011B amplifier tube unit for Electrocardiograph.

G-E MODEL B ELECTROCARDIOGRAPH

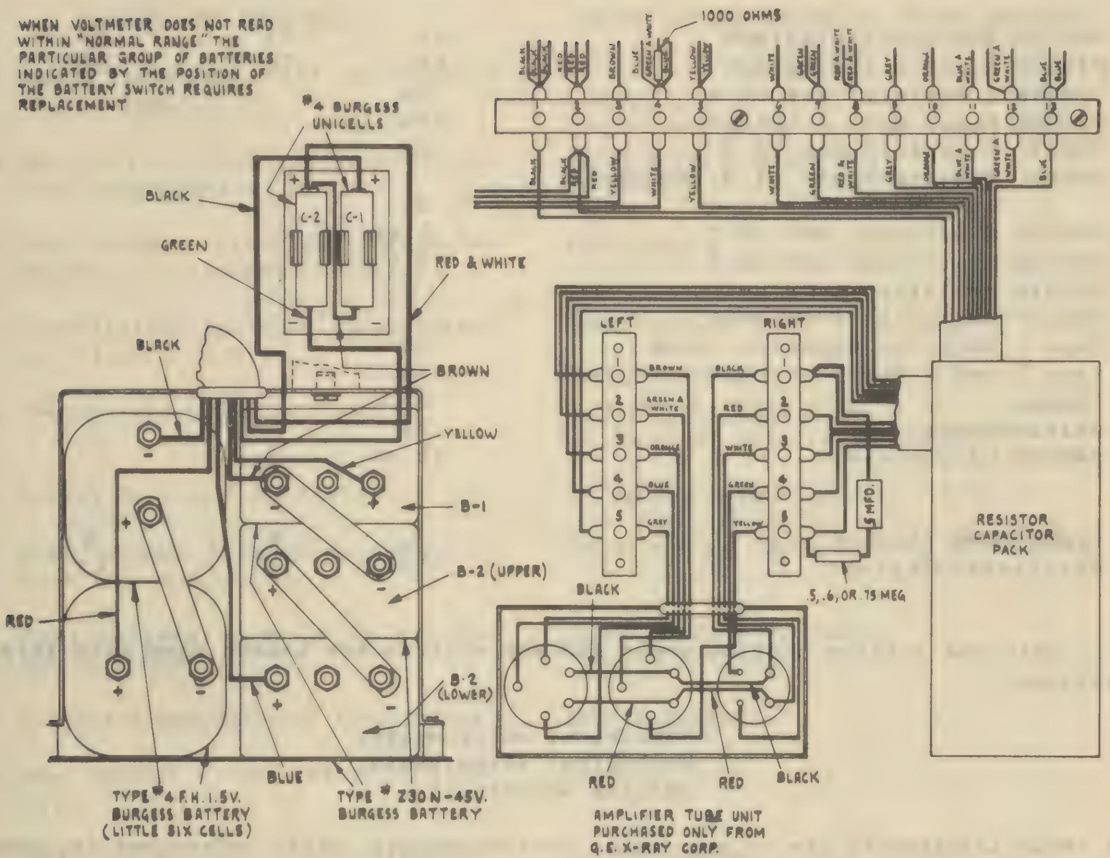


DIAGRAM OF CONNECTIONS

PATIENT'S CABLE - The cable connecting the patient to the electrocardiograph is of special construction, shielded to reduce external pickup and selected for flexibility and durability. It is quite possible, however, that following a reasonable period of use a break may occur. If the break is at the trifurcated end near the electrode terminal, the broken section of the conductor can be removed and connection made by soldering the free end to the terminal. If the break is inside the cable proper, a new cable should be installed.

If a break occurs in one patient lead, it will be manifested by erratic action of the beam of light in two of the three leads of the Electrocardiogram. This is due to the fact that only two of the three conductors are used at any one time. Hence, in one lead the damaged conductor will not be used.

PHYSICAL DATA

WEIGHTS (Pounds	Net	Domestic Gross	Export Gross
P7010A Electrocardiograph	47	71	90
P7010B Electrocardiograph	46¼	70	89
P7009B A Battery, set of 2	2¾		
P7009C Heavy duty A battery	13¾		
P7007C B battery, set of 2	2½		
P7007C B battery, set of 2, shipped in tin can for export	3½		
P7015A C battery, set of 3	3 oz.		
P7015B C battery, set of 2	2 oz.		
P7011A Amplifier tube unit	½		
P7011B Amplifier tube unit	½		
Type 1 Resistor-capacitor pack	1½		
Type 2 and 3 Resistor-capacitor pack	1¾		
Camera	5		
Galvanometer	2½		
F4002B Cardiopaper	10 oz.		

DIMENSIONS (Inches)	L	W	H
Electrocardiograph	19	10	12

Both the service outline chart and the article are broken down into three sections:

Electrical adjustments.
Mechanical adjustments.
Optical adjustments.

As these adjustments are in many cases interdependent, cross references are used freely in the article so that one may quickly obtain all the information required to clear up certain types of difficulty.

The service outline chart is particularly useful in this respect. Across the page are listed manifestations of various difficulties. After the heading under which disorder falls is found, reference is made to the column in which various causes of the trouble are listed. These causes appear in an order of frequency at which they are most likely to occur. The second column shows the heading under which the trouble is discussed and the solution suggested.

Much of the service trouble presented in the article seldom occurs, yet no effort was spared to make the article as complete as possible.

ELECTROCARDIOGRAPHS

SERVICE OUTLINE CHART

ELECTRICAL ADJUSTMENTS

MANIFESTATION OF TROUBLE - Base line intermittently or continuously irregular on lead selector position "S" as well as on all patient's positions with motor running or stationary.

CAUSES OF TROUBLE	REFER TO DESCRIPTION UNDER HEADING
1. Loose terminal nuts on A and B batteries.	
2. Main switch improperly wedged in "ON" receptacle.	Turning main switch on.
3. Dirt between slider and resistance winding of filament control.	Poor contact.
4. Insufficient spring slider tension in filament control.	Poor contact.
5. Faulty tube unit.	1. Unsteady base line. 2. Internal defective contact.
6. Faulty A, B or C batteries.	Irregular base line.
7. Poor contact between galvanometer bulb and socket.	Poor contact between lamp and socket.
8. Poor internal contact in galvanometer lamp.	Poor contact in lamp.
9. Defective galvanometer lamp socket.	Faulty socket.
10. Poor contact at voltmeter terminals.	Unsteady beam.
11. Poor internal contact in voltmeter.	Unsteady beam.
12. Poor contact inside galvanometer.	Poor contact in galvanometer.
13. Poor contact in lead selector and battery test switches.	Cleaning switches.
14. Poor soldered or unsoldered connection elsewhere in the circuit.	

MANIFESTATION OF TROUBLE - Base line intermittently or continuously irregular on lead selector positions 1, 2, and 3, with motor running or stationary. Steady on lead selector position "S".

1. Electrode skin area insufficiently massaged with paste.	Electrodes.
2. Electrodes are too loosely or too tightly attached.	Electrodes.
3. Electrodes are corroded.	Electrodes.

CAUSES OF TROUBLE	REFER TO DESCRIPTION UNDER HEADING
4. Patient not properly prepared.	1. Somatic tremor 2. Preparation of patient.
5. Some patients never produce satisfactory tracing.	1. Positioning patient. 2. Breathing.
6. Poor soldered connection at patient lead cord tip.	Conductor broken partially.
7. One or more patient's cord leads partially broken.	Conductor broken partially.

MANIFESTATION OF TROUBLE - Base line steady on all lead selector positions when motor is not running. Becomes intermittently or continuously unsteady after motor is started.

1. Patient's cord lead is rubbing, against or grounded to motor spring drum.	Grounded patient's cable.

MANIFESTATION OF TROUBLE - Base line jumps on all lead selector positions when operating lead marker and other controls or touching the instrument.

1. Main switch improperly wedged in "ON" receptacle.	Turning main switch on.
2. Loose terminal nuts on A and B batteries.	
3. Insufficient spring slider tension in filament control.	Poor contact.
4. No clearance between control knobs and instrument panel top.	Removal of apparatus panel.
5. Charge carries static charge.	Static charge.
6. Excessive jarring when handling instrument and control.	Mechanical shock and jarring.
7. Poor soldered or unsoldered connection elsewhere in the circuit.	

MANIFESTATION OF TROUBLE - Base line remains stationary when standardizing, but deflects from heart action.

1. Unsoldered pigtail connections at standardization switch.	Failure to cause beam deflection.
2. Contact spring of standarization switch not touching contact sector.	Failure to cause beam deflection.
3. Open circuit in high standardization resistor. .212 megohm inside resistor-capacitor pack.	Failure to cause beam deflection.

MANIFESTATION OF TROUBLE - Base line remains stationary when standardizing and on lead selector positions 1, 2, 3.

CAUSES OF TROUBLE	REFER TO DESCRIPTION UNDER HEADING
1. Discharged B batteries.	Low voltage.
2. Open circuit in sensitivity control.	Open circuit.
3. Open circuit in galvanometer.	Open circuit.
4. Magnetic vane came off string in galvanometer.	Loose magnetic vane.
5. One or more filaments in amplifying tubes damaged.	Broken or burned out filament.
6. Broken connection elsewhere in the circuit.	

MANIFESTATION OF TROUBLE - Base line deflections from heart action gradually decrease or cease after lead selector moved to new patient's lead position.

1. Excessive skin potentials swing first stage tube grid negative causing blocking action.	"Paralyzed beam".

MANIFESTATION OF TROUBLE - Decreased amplification - maximum amplification on lead selector position "S" when standardizing and with sensitivity control at maximum setting is less than 15 mm.

1. Low B batteries.	Low voltage.
2. Faulty tube unit.	Decrease or increase in amplification.
3. Loose galvanometer coil lying against mirror or magnetic vane in galvanometer.	Loose galvanometer coil.
4. Voltmeter reading high.	Voltmeter inaccurate.

MANIFESTATION OF TROUBLE - Excessive amplification - minimum amplification on lead selector position "S" when standardizing and with sensitivity control at minimum setting is more than 10 mm.

1. Faulty B batteries.	Excessive amplification.
2. Faulty tube unit.	Decrease or increase in amplification.
3. Open circuit in sensitivity control.	Open circuit.
4. Voltmeter reading low.	Voltmeter inaccurate.

MANIFESTATION OF TROUBLE - Inconsistent variable amplification - base line deflection varies in height from one standardization mark to another.

1. Faulty tube unit.	Variable amplification.

MANIFESTATION OF TROUBLE - Consistent variable amplification - base line deflection decreases more than 10% during a run of 5 minutes.

CAUSES OF TROUBLE	REFER TO DESCRIPTION UNDER HEADING
1. Old or used up A batteries.	Low voltage.
2. Faulty tube unit.	Decrease or increase in amplification.

MANIFESTATION OF TROUBLE - A battery discharges in unreasonably short time.

1. Main switch left in "ON" receptacle for several hours.	
2. Replacement A batteries defective.	Low voltage.

MANIFESTATION OF TROUBLE - B battery discharges in unreasonably short time.

1. Battery test switch left on "B-1" or "B-2" positions for long time.	
2. Replacement B batteries defective.	
3. Grounded sensitivity control.	Grounded sensitivity control.
4. Grounded galvanometer.	Grounded galvanometer.

MANIFESTATION OF TROUBLE - C battery discharges in unreasonably short time.

1. Battery test switch left on "C-1" or "C-2" positions for long time.
2. Replacement C battery defective.

MANIFESTATION OF TROUBLE - Beam does not settle down but undergoes gradually diminishing oscillations when operating standardization switch.

1. Faulty B-1 battery.	Damped oscillations.
2. This condition may occur if somewhat old B-1 battery is subjected to cold.	Damped oscillations.

MANIFESTATION OF TROUBLE - Beam goes in sustained self-oscillation with lead selector on position "S".

1. Faulty B-1 battery.	Sustained oscillations.

MANIFESTATION OF TROUBLE - Base line dips more than 1/4 mm. following standardization mark with amplification set for 10 mm.

1. Improperly operated standardization switch can be responsible.	Circuit closing time too long.
2. Faulty tube unit.	Dip in base line.

MANIFESTATION OF TROUBLE - Microphonic action - the base line appears to become thinner with sensitivity control set for 10 mm. deflection when controls are operated or the instrument slightly jarred. If tracing is made fast oscillations will be noted.

CAUSES OF TROUBLE	REFER TO DESCRIPTION UNDER HEADING
1. Controls are not handled gently. The instrument is excessively jarred.	Mechanical shock and jarring.
2. Microphonic tube unit.	Microphonic action.

MANIFESTATION OF TROUBLE - Downward stroke of standardization mark shows slurring and slow resolution at base line.

1. Faulty tube unit.	Slurring of base line.

MANIFESTATION OF TROUBLE - Base line executes downward and then upward deflection as observed on calibration scale when standardizing or on the finished tracing.

1. Standardization switch pressed too long.	Circuit closing time too long.
2. Standardization switch contact spacing excessive.	Excessive contact spacing.

MANIFESTATION OF TROUBLE - Beam cannot be brought in view or in center of calibration scale.

1. Grounded sensitivity control.	Grounded sensitivity control.
2. Grounded galvanometer.	Grounded galvanometer.
3. Loosened mirror in galvanometer.	1. Loose mirror in galvanometer. 2. No reflected light from galvanometer.
4. Galvanometer mirror turned and sticking to one side.	Galvanometer mirror turned and sticking to one side.

MANIFESTATION OF TROUBLE - Low amplification. Illuminated field as observed on calibration scale does not move in unison with beam control.

1. Loosened coil in galvanometer.	Loose galvanometer coil.

MANIFESTATION OF TROUBLE - No reflected light from the galvanometer mirror.

1. Loosened mirror in galvanometer.	1. Loose mirror in galvanometer. 2. No reflected light from galvanometer.

MECHANICAL ADJUSTMENTS

MANIFESTATION OF TROUBLE - Several inches of cardiopaper fogged at beginning of record.

1. Camera improperly loaded - cardiopaper not tight against slide.	Proper method of loading and handling camera.

MANIFESTATION OF TROUBLE - Extensive fogging of entire tracing.

CAUSES OF TROUBLE	REFER TO DESCRIPTION UNDER HEADING
1. Camera subjected to strong light without covering slot or carrying camera in light-tight bag.	Proper method of loading and handling camera.

MANIFESTATION OF TROUBLE - Several inches at beginning of some or all leads are darker than the balance of tracing.

1. Motor not fully wound.	
2. Excessive tension of spring connected to friction lever in camera.	Bent friction lever or excessive friction.
3. Defective motor.	Motor binds, stops, or varies in speed.

MANIFESTATION OF TROUBLE - Timing and ruling lines fuzzy on one edge of tracing.

1. Camera improperly loaded.	Proper method of loading and handling camera.
2. Friction lever bears on fresh roll on only one edge.	Bent friction lever or excessive friction.

MANIFESTATION OF TROUBLE - Frequent dark and light streaks on record.

1. Defective motor.	Motor binds, stops, or varies in speed.

MANIFESTATION OF TROUBLE - Motor cannot be fully wound by turning winding crank.

1. Spring in motor drum broken.	Broken spring.

OPTICAL ADJUSTMENTS

MANIFESTATION OF TROUBLE - Insufficient illumination requiring long developing time to produce tracing of proper density.

1. Improper adjustment of galvanometer lamp.	Adjustment and replacement of galvanometer lamp.
2. Darkened galvanometer lamp.	Insufficient illumination - long developing time.
3. Dirty optical elements or galvanometer window.	Insufficient illumination - long developing time.
4. 45° camera mirror not fully covered with light.	Insufficient illumination - long developing time.
5. Low reading voltmeter.	Voltmeter inaccurate.

MANIFESTATION OF TROUBLE - Transparent base line - timing and ruling lines discernable in base line.

CAUSES OF TROUBLE	REFER TO DESCRIPTION UNDER HEADING
1. Oil in galvanometer window.	Transparent base line.
2. Wire pin too low.	Transparent base line.
3. Dust or dirt on other optical elements.	Transparent base line.
4. Tracings developed to too dark density.	Transparent base line.

MANIFESTATION OF TROUBLE - White dots formed at cross-section of timing and ruling lines.

1. Camera condensing lens out of adjustment.	White dots on cross-section of timing and ruling lines.
2. Tracings developed to too dark density.	White dots on cross-section of timing and ruling lines.

MANIFESTATION OF TROUBLE - Fuzzy base line on tracing.

1. Wire pin bent so that its shadow is not perpendicular to long axis of 45° camera mirror.	1. Fuzzy base line on tracing. 2. Final adjustment of wire pin.
2. Wire pin not properly placed with respect to galvanometer mirror principal focus.	1. Fuzzy base line on tracing. 2. Final adjustment of wire pin.
3. Camera condensing lens out of adjustment.	1. Fuzzy base line on tracing. 2. Final adjustment of wire pin.
4. Faulty galvanometer mirror.	1. Fuzzy base line on tracing.

MANIFESTATION OF TROUBLE - Timing and ruling lines fuzzy on one edge of tracing.

1. This condition occurs inconsistently:	
a. Cardiopaper improperly loaded.	Proper method of loading and handling camera.
2. This condition occurs consistently:	
a. Camera lens and slide not parallel.	1. Timing and ruling lines fuzzing on one edge of tracing. 2. Final adjustment of wire pin.
b. Friction lever bearing with one edge only on unexposed roll.	1. Timing and ruling lines fuzzy on one edge of tracing. 2. Bent friction lever and excessive friction.
c. Cardiopaper climbing on ridge on slide.	Timing and ruling lines fuzzy on one edge of tracing.

MANIFESTATION OF TROUBLE - "Ghost" shadow: white streaks along tracing, dark spots on calibration scale.

CAUSES OF TROUBLE	REFER TO DESCRIPTION UNDER HEADING
1. "Ghost" shadow is a straight line or stationary dark spots on calibration scale.	
a. Dirt particles on optical elements of reflected illumination.	"Ghost" shadow on tracing.
b. Wire pin too high.	Initial adjustment of wire pin.
2. "Ghost" shadow follows base line deviations from heart action.	
a. Dirt particles on optical elements of direct illumination.	"Ghost" shadow on tracing.

MANIFESTATION OF TROUBLE - No reflected light from galvanometer.

1. Rotation of galvanometer.	1. No reflected light from galvanometer. 2. Initial adjustment of optical elements.
2. Galvanometer mirror came off string.	1. No reflected light from galvanometer. 2. Loose mirror in galvanometer.
3. Grounded galvanometer.	1. No reflected light from galvanometer. 2. Grounded galvanometer.
4. Grounded sensitivity control.	1. No reflected light from galvanometer. 2. Grounded sensitivity control.
5. Mirror sticks to one side.	1. No reflected light from galvanometer. 2. Galvanometer mirror turned and sticking to one side.

MANIFESTATION OF TROUBLE - White conical streaks on tracing opposite tall heart deflections.

1. Base line placed near wrong edge. of calibration scale.	White conical streaks.
2. Wire pin not in center of illuminated field.	White conical streaks.

MANIFESTATION OF TROUBLE - Uneven density on one edge of tracing.

1. Galvanometer lamp improperly adjusted.	1. Uneven density on one edge of tracing. 2. Adjustment and replacement of galvanometer lamp.
2. Excessive dust or dirt on optical elements.	Uneven density on one edge of tracing.
3. Color in reflected illuminating field.	Uneven density on one edge of tracing.

The larger percentage of the troubles experienced with the Model B Electrocardiograph calls for changing the batteries or the galvanometer lamp, cleaning the elements comprising the optical system, tightening contacts and connections, or effecting other simple adjustments. This requires usually but a few minutes of time and a simple assortment of tools.

REMOVAL OF APPARATUS PANEL - In servicing Model B Electrocardiographs occasions for removal of the apparatus top panel will sometimes arise. This can be simply effected by removal of screws on each of the four corners of the panel and then removal of the various control knobs and devices. Use a wrench for Bristo socket set screw 8-32 supplied with each instrument to loosen the knobs on their shafts. The top panel can now be lifted and turned at an angle to expose the part requiring service. Do not raise the panel too high to prevent injury to the voltmeter leads.

Occasionally the knob may freeze on its shaft requiring placing a screw driver under the knob and forcing it up.

When replacing the knobs be sure to place the indicators in correct position with relation to the markings on the control panel. Allow at least 1/32" clearance between the lower surface of the knobs and the metal top. Failure to do so may cause improper operation of the apparatus.

In territories of high humidity the knobs should be periodically removed and the control shafts thinly coated with vaseline to prevent rusting anc consequent freezing of the knobs.

ELECTRICAL ADJUSTMENTS

In amplifier type electrocardiograph the heart voltages are amplified several hundred times before they are impressed across the galvanometer. Quite obviously even a slight variation in voltage or current brought about by faulty contact or defective part in the instrument will also be amplified a great many times interfering or entirely distorting the heart tracing. Realizing that poor contact rarely develops in soldered connections, majority of the connections in the Model B Electrocardiograph are soldered. When some trouble of electrical nature is experienced examine, as a rule, unsoldered contacts first, then limited life parts such as batteries and amplifying tubes next, and soldered connections last.

Poor contact in the circuit of the first stage tube is likely to produce greater amount of distortion, less if it occurs in the second stage, and the least if present in the circuit of third stage tube.

MAIN SWITCH - The main switch is of the tapered plug type which is the most satisfactory circuit-making device obtainable for this purpose. The position labeled "OFF" is simply a receptacle for the tapered plug. To turn the instrument on, lift the plug out of this receptacle, place it in the one labeled "ON", pushing it down, and simultaneously turning it clockwise. This will wedge the plug into position and insure firm contact.

TURNING MAIN SWITCH ON - If the main switch is not properly wedged in the receptacle poor contact may result. This will cause erratic beam on the calibration scale when handling various controls, or slightly jarring the instrument. If the plug is turned counterclockwise after being dropped into the "ON" receptacle, the insulating knob may come off. A few minutes spent on instructing the operator in the proper use of main switch will eliminate these difficulties and may save a service trip in the future.

CLEANING SWITCH - This switch is of the self-wiping type and rarely if ever will require attention. If it becomes dirty, it should be cleaned with a rag moistened in alcohol or acetone. Sanding of this switch is not recommended since the plug forms a ground joint with the receptacle.

FILAMENT CONTROL - The filament control in the Model B Electrocardiograph is of a series resistance type having a resistance of 1-ohm. It is used to reduce the voltage of the A battery to a certain predetermined value which is obtained when voltmeter needle rests on the "ON" mark. Raising the voltage above this setting is not recommended because the standardization deflection will no longer represent one millivolt.

POOR CONTACT - Occasionally a poor contact between the resistance and the contact slider may develop. If the contact is very poor, slight variations in the voltage as observed on the voltmeter may be noted. The voltmeter needle may, however, remain steady even though the filament control causes unsteady action of the beam due to poor contact.

Dirt under the contact slider or insufficient spring tension are responsible. The former difficulty can usually be eliminated by turning the filament regulator several times quickly from one end to the other. If the latter type of difficulty is present, it is best to replace the filament control.

As poor contact may not occur consistently, and the equipment may operate satisfactorily while making a service call, the following test is recommended for ascertaining whether the filament regulator is faulty or not. Turn on the instrument and allow the beam to stabilize. Watch the beam on the sensitivity scale while tapping the control knob very lightly. If the filament control is in a satisfactory condition, the beam should remain motionless or undergo a slight deflection and quickly return to the original position. On the other hand, if the contact is poor, tapping the control knob lightly will cause the beam to go off scale or result in a large downward and then upward dellection, requiring several seconds for the beam to settle down.

Excessive tapping or a slight lateral pressure of the control knob will invariably cause a large deflection even if the filament control is satisfactory. Do not, therefore, use this method as a criterion for determining the condition of the filament control.

REPLACEMENT OF FILAMENT CONTROL - To effect the replacement of the filament control, the various knobs on the control panel should be removed and the control top lifted and turned at an angle to expose the filament control unit. Remove the old filament control and mount the new unit. Using rosin core solder, solder the leads in the same manner as they were soldered before.

SENSITIVITY CONTROL - The sensitivity control employed in the Model B Electrocardiograph is of the potentiometer type having a resistance of 10,000-ohms. This potentiometer is used in series with a 1000-ohm fixed resistance and the combination of these two is connected across the galvanometer. The scheme of connection is shown in Figures 21A and 21B. It will be noted that changing the position of the variable slider controls the voltage impressed across the galvanometer which, in turn, varies the amplification.

OPEN CIRCUIT - Manifestation of open circuit depends entirely on just where it occurred. Thus, if the wire is open at A no voltage can be impressed across the galvanometer regardless of the position of the variable slider. If the open

circuit is at B, no beam deflection will occur when operating the standardization switch with the slider placed within the range BC of the potentiometer winding. If, on the other hand, the slider rests in the range AB, the galvanometer will be placed in circuit. The beam will deflect when operating the standardization switch, but the minimum amount of deflection will be excessive, probably greater than 10 mm. When the resistance is open at C, the beam will deflect on standardizing but the amount of deflection on minimum setting of the sensitivity control will be excessive.

GROUNDED SENSITIVITY CONTROL - If the sensitivity control is grounded it will not be possible to make the galvanometer mirror face straight forward by turning the beam control. Consequently, the beam could not be brought into the center of the calibration scale even though beam control is moved from one extreme to the other. The ground will also cause a heavy current drain from B batteries under which condition the batteries will become quickly discharged. A simple diagnosis of this condition can be made by disconnecting the lead from terminal of B-2 (lower) battery and noting if the beam can be brought to the center of the calibration scale. Another method is to insert a D.C. milliammeter in series with + terminal of B-2 battery and observe its reading after the unit is fully stabilized. If it is considerably greater than 3 MA. ground is present requiring the replacement of the sensitivity control. If the condition is not remedied following the replacement, the galvanometer may be grounded.

REPLACEMENT OF SENSITIVITY CONTROL - In order to effect the replacement of the faulty sensitivity control, remove all the knobs on the control panel, then lift and turn the cover in order to get access to this control. Unsolder the three wires from the connecting lugs, and change the control unit.

STANDARDIZATION SWITCH - The function of the standardization switch is to impress a potential 1 millivolt on the input side of the amplifier for calibration purposes.

PUSH BUTTON TYPE STANDARDIZATION SWITCH.

DIRTY OR CORRODED CONTACTS - The contacts used in push-button standardisation switch are made of silver and will seldom corrode. However dirt or foreign particles on the contacts may prevent obtaining good contact when the switch is operated. Thus artifacts may appear on the top of the mark and thereby distort the standardization deflection. Remove the control knobs and turn the top panel in order to expose the switch assembly. Draw a strip of fine sandpaper between the contacts while lightly pressing them together and finish cleaning by drawing a piece of clean paper.

CIRCUIT CLOSING TIME TOO LONG - In order to secure a satisfactory standardization mark, the push-button must be quickly pressed and released. It will be noted on examining the standardization mark on the finished tracing taken in this manner that the top is square and the break in the base line is not more than two 1/25 second divisions. If the contact of longer duration is made the beam decay will set in and the dip in the base line will occur on completion of the deflection. Although the appeaaance of the mark will be poor, the initial upward deflection represents nevertheless the deflection caused by impressing one millivolt. Perhaps the best method of operating the switch when recording the mark is to poise a finger about half an inch above the push-button and then quickly tap or strike the button.

CONTACT SPACING - The contact spacing should be .007" or approximately the thickness of cardiopaper.

FAILURE TO CAUSE BEAM DEFLECTION - If the beam deflects from the heart action but fails to show deflections on standardization, an open in the standardization switch circuit should be suspected unless it is not making contact when switch is operated. Examine the two pigtails to the standardization switch, and resolder the connections if necessary. Also revise connections under the switch assembly board. If there is no fault in the connections, examine for unsoldered wires at terminals 2 and 11. See Figures 19A and 19B for identification of these terminals. If no difficulty is discovered in the connections at these terminal lugs, the .212 megohm high standardization resistor in the amplifier pack may be open circuited. The open circuit can be definitely verified by connecting an ohmmeter to terminals 11 and 12. If the ohmmeter does not record, this resistance is open and the amplifying pack requires replacement.

LEAD SELECTOR AND BATTERY TEST SWITCHES - The sliding arms of these switches are made of four bronze springs. The sliding surface of the arms is ground, and they are so adjusted in the factory that a contact of uniform pressure is secured between each individual blade and the contact button.

CLEANING SWITCHES - Readjustment of tension of these blades will very seldom be necessary, but two or three times a year the contact buttons should be cleaned with a piece of cloth slightly moistened in alcohol or carbon tetrachloride. The switches should then be moved from one extreme to the other several times and the contact buttons cleaned again. Then coat the buttons with a very thin film of vaseline for lubricating purposes. Do not increase the tension of the sliding arms because the inner springs will bear with greater pressure on the contact button than the outer springs. Uneven wear of the buttons will result eventually requiring more extensive servicing. If it is absolutely necessary to increase the tension, loosen the Allen head set screw 10/32 in the lower nut on the switch shaft and turn this nut a small fraction of a turn. Retighten the set screw.

VOLTMETER - The voltmeter is actually a D.C. milliammeter calibrated to read the voltage. This meter is ruggedly built and will seldom cause any trouble. Its internal resistance is 50-ohms.

VOLTMETER STICKING - Occasionally the voltmeter may stick in one or several positions of the dial. If the voltmeter sticks, it should be removed for repair or replaced with a new meter.

VOLTMETER INACCURATE - In order to check the accuracy of the voltmeter, a low reading, correctly calibrated D.C. milliammeter is required. Open the back door and remove one of the leads to the voltmeter. Connect the milliammeter in series with the voltmeter on the panel and turn on the main switch, making sure that the battery test switch is on position "A". Turn the filament regulator until the voltmeter needle rests exactly on the "ON" mark. The D.C. milliammeter should read 6 MA .2 MA. If the error is greater, the voltmeter adjustment screw should be turned until the voltmeter needle rests on the "ON" mark with the milliammeter reading 6 MA. If turning the adjustment screw fails to bring the voltmeter needle on the mark, the voltmeter should be replaced.

UNSTEADY BEAM - During normal recording of the tracing, the battery test switch should always be left on position "A". This automatically connects the voltmeter across the A battery circuit. If there is a poor contact at the voltmeter terminals or inside the voltmeter, the current drawn by the voltmeter from the A battery will vary, thereby causing voltage fluctuation in the A battery circuit and consequent unsteady beam as observed on the calibration scale. If the voltmeter is suspected, remove the leads from both terminals of the voltmeter and

note if the beam becomes steady. If so, there existed poor contact at the terminals or inside the voltmeter. If the difficulty cannot be remedied, a replacement voltmeter should be installed.

VOLTMETER REPLACEMENT - In order to replace the voltmeter, the top panel must be removed, the screw on the bezel near the panel loosened, and the voltmeter leads removed. Follow the reverse procedure for installation of a new voltmeter.

BATTERIES - The batteries selected for use in the Model B Electrocardiograph are made by the Burgess Battery Company. As the batteries have a limited life which is affected by a number of conditions such as age, frequency of use, current drain, mechanical shocks, as well as climatic conditions, they will require fairly frequent replacement.

The age of the batteries can be determined from the date stamped on each battery remembering that it is one year in advance of the date of the manufacture of the battery.

The voltmeter and battery test switch are provided for measuring the voltage of the batteries. It should be borne in mind that the voltage of the batteries within normal limits is not always an indication of their internal condition. Batteries may be faulty, causing erratic operation of the instrument even though the voltage readings are normal.

A BATTERIES - The A batteries are identified as Burgess #4FH Little Six Dry cells. These batteries are 1.5-volts each and are connected in series by means of a metal link. They supply the current for the filaments of the amplifying tubes and galvanometer lamp. The operating current drain from these batteries is approximately 1.1 ampere. The frequency at which batteries will require replacement depends upon the amount of service to which the unit is put. The average life is approximately 20 hours actual operating time, or about two months on the basis of six tracings daily.

To test the voltage of the A battery, turn on the main switch and rotate the filament control coockwise as far as it will go. The voltmeter needle should read within the range marked "NORMAL". If it does not pass the "ON" position, replacement should be made. Consult Figure 19 for properly connecting the replacement batteries.

LOW VOLTAGE - If the voltmeter needle fails to pass the "ON" mark with the filament regulator turned all the way clockwise, the batteries are low and should be changed. It is also advisable to effect replacement if the voltage drops appreciably (1/6 inch from original position) during the recording of a single tracing.

A recently installed battery may give a low voltage reading. It is permissable in such a case to determine and eliminate a single battery the voltage of which is low. If the batteries have been used for an appreciable length of time and if they are reading low because of failure to turn off the instrument, it is best to effect replacement of both batteries.

IRREGULAR BASE LINE - Occasionally the A battery may become defective internally causing unsteady base line with the lead selector on position "S". After having made sure that the difficulty is not caused by a poor and loose connection at the batteries, change the batteries.

BATTERIES - The present B batteries employed in the instrument are Burgess

#Z30N batteries. They are 45 volts each and are connected in series with a metal link. The life expectancy of B batteries is approximately six months, based on six tracings daily. Consult Figure 19 for properly connecting the batteries.

LOW VOLTAGE - If the voltage of the batteries is not within normal range, the batteries should be changed because they may cause trouble in the near future even though : the time they may be functioning satisfactorily. To measure the voltage of the B-1 battery turn the battery test switch to "B-1" position. If the voltmeter needle is not within the "NORMAL" range, the battery is low. With the battery test switch in position "B-2", the voltmeter reads the combined voltage of the two B batteries connected in series. Therefore, before condemning the B-2 battery, be sure the B-1 battery reads normal. If B-1 battery is low, change it before B-2. Then with the battery switch on "B-2", read the combined voltage of the two batteries. If the B-1 battery reads normal and the combined voltage of the two batteries is below normal, also change the B-2 battery. Where both batteries have given a reasonable amount of service, they should be replaced even though one may still show normal voltage.

EXCESSIVE AMPLIFICATION - Occasionally, faulty B batteries can cause excessive amplification to such extent that minimum beam deflection obtainable will be greater than 10 mm. Replacing the batteries with a new set will quickly prove whether excessive amplification is caused by defective batteries. In emergencies the battery test switch may be placed for one or two minutes on B-2 position in order to restore them temporarily to normal condition. If on the other hand the difficulty continues, consult the sections on tubes and sensitivity control.

IRREGULAR BASE LINE - It is possible for B batteries, either new or old, to develop a defective internal contact. Batteries having a defective internal contact will cause unsteady base line. To diagnose and eliminate this difficulty, new batteries should be installed.

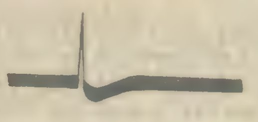
DAMPED OSCILLATIONS - One manifestation of faulty B batteries is a single or multiple wave oscillations following application of standardization voltage by operating the standardization switch with the lead selector switch on position "S". The single wave curves downward following the standardization mark, then gradually returns to the level of the base line. This is shown in Figure 10. Reasonably fresh batteries exposed to cold may also cause single wave oscillation following standardization mark. This condition may disappear after the instrument has warmed up. If time is a factor turn the battery test switch for one or two minutes on B-2 positions. This will draw additional current from the B batteries and restore them quickly to operable condition. Damped multiple oscillations following operation standardization switch may be of fast or slow resolving nature. This is shown in Figures 11 and 12.

This condition can be overcome by replacing the B batteries. In emergency, changing the B-1 battery to the lower position and putting the B-2 battery in the upper position may overcome the difficulty provided the B-2 battery is in good condition. A slightly faulty battery in B-2 oisutuib nat bit affect operation of the instrument; when placed in B-1 position it will cause erratic operation. Temporary resotration of B batteries to normal condition may frequently be obtained by placing the battery test switch to B-2 position for a few minutes.

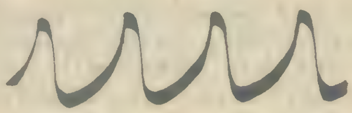
SUSTAINED OSCILLATION - Sustained oscillations can also be caused by faulty batteries. In order to observe the nature of these oscillations or record them on the tracing, the sensitivity control must be set for minimum amplification. These oscillations may be of continuous type shown in Figures 13 and 14 or the

discontinuous type shown in Figure 15. A milliammeter placed in series with + terminal of B-2 battery will follow these oscillations. It is also possible to note these oscillations on the voltmeter by turning the battery testing switch to the "B-1" or "B-2" position. Do not make these tests on lead selector positions other than "S". The beam will fluctuate on other positions without a patient being connected in the circuit which is a normal characteristic of the instrument.

C BATTERIES - The C batteries used in the Model B Electrocardiograph are 1.5-volt Burgess #4 Unicells. The C-1 battery is used for providing bias on the grids of the first and second stage tubes, and the C-2 battery connected in series with the C-1 serves to bias the grid of the third stage tube. As the current drain from these groups of batteries is exceedingly small, the batteries are expected to last for approximately one year.



SINGLE WAVE DAMPED OSCILLATION
FIG. 10

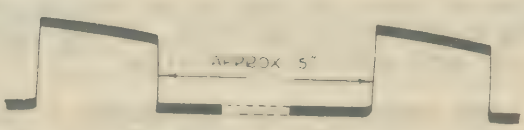


CONTINUOUS FAST OSCILLATIONS
FIG. 13

MULTIPLE DAMPED FAST RESOLVING OSCILLATIONS
FIG. 11

CONTINUOUS SLOW OSCILLATIONS
FIG. 14

MULTIPLE DAMPED SLOW RESOLVING OSCILLATIONS
FIG. 12



DISCONTINUOUS OSCILLATIONS
FIG. 15

In order to measure the voltage of these two groups of batteries, turn the battery test switch to positions C-1 and then to C-2. The main switch should be in the "ON" position when making this test.

LOW VOLTAGE - If the voltmeter needle does not rest within the normal range when testing C batteries as described above, replacement should be effected. These batteries are very inexpensive and it is recommended that a complete group of batteries be replaced even though only one battery may require replacement.

IRREGULAR BASE LINE - Occasionally faulty C batteries may cause unsteady base line. Remove the C battery mounting block and examine the cells. They should not be excessively squeezed or moist.

Squeezing is caused by excessive spring clip tension. Should it be found that the clips squeeze the batteries, the spring pressure should be relieved. When any one cell is moist it should be replaced at once, especially if the cell in question is in the clip attached to the thumbscrew which serves to hold the mounting

block in place. The moisture is the electrolyte leaked out from the cell due to excessive squeezing or corrosion of the shell. Unstable action of the beam will be observed if the wrapping is moist on the cell placed in the clip which is connected to the thumbscrew.

GROUNDED C BATTERIES - The C batteries are held in place by means of the clips attached to the mounting block. One of these clips is electrically connected to the thumb nut used for fastening the terminal block in the battery compartment. A paper wrapping around the C-battery cell insulates this battery from ground. Should this wrapping wear out, the C battery cell will be grounded. To prevent this occurance, a piece of fish paper cut approximately 1¾" by 3/4" should be wrapped about the cell before placing it in the clip. If fish paper is not available, a piece of heavy bond writing paper may be substituted.

If the cell becomes dead grounded, a negative reading on the voltmeter will be obtained with the main switch turned off and the battery test switch on position "A". Turning on the main switch will cause the voltmeter to drop nearly to zero. This will put a short across the A battery as well as the entire group of C batteries.

REPLACEMENT OF C BATTERIES - If the batteries are low, or if they are suspected of causing unsteady base line, the entire set of batteries should be replaced. Remove the C battery terminal block from the battery compartment and place it in the position shown in Figure 19. *CAUTION:* Do not allow the block to fall down on the B battery terminals. If C battery cell comes in contact with B battery, the B battery voltage will be impressed on the filaments of the tubes and galvanometer lamp causing them to burn out. The use of a tall cardboard box placed alongside the B batteries for supporting the C battery block while replacing the batteries will prevent this occurrance. Unsolder the wires and insert the new batteries in the same manner as they were placed before. Scrape the center terminal and a small area on the bottom of each cell and solder the connecting wires in accordance with Figure 19 using rosin core solder only. Do not apply soldering iron longer than necessary to secure good soldered connection.

GALVANOMETER LAMP AND SOCKET - The galvanometer lamp used in the Model B Electrocardiograph is a special lamp rated 2.4-volt, .6 ampere and selected for good internal contact and proper dimensions. Replacement of this lamp with a lamp available locally should not be attempted.

POOR CONTACT BETWEEN LAMP AND SOCKET - Poor contact may be present between the galvanometer lamp and the center contact spring in the socket. If it is found that this spring is flattened against the base, raise it a slight amount and then clean the spring and the drop of solder on the base of the lamp with sandpaper. Screw the lamp in the socket and retest the unit.

POOR CONTACT IN LAMP - Occasionally a poor contact may develop within the lamp. Even a very slight fluctuation of current drawn by the lamp brought about by poor internal contact will cause the beam to fluctuate as observed on the sensitivity scale. When erratic action of the beam is present, the galvanometer lamp may be suspected as a source of trouble. Change the lamp, adjust it as described under the section covering optical adjustments and recheck the instrument. If the trouble continues, it is obviously present somewhere else in the circuit.

FAULTY SOCKET - Faulty contact may also occur in the galvanometer lamp socket. If erratic action of the beam persists following other adjustments and replacements, the galvanometer lamp socket may be suspected. To effect the socket replacement, unsolder the two leads at the lugs of the socket and resolder to the lugs of the new socket.

AMPLIFIER TUBE UNIT - The vacuum tubes used in the Model B Electrocardiograph are standard radio tubes especially selected by the manufacturer and carefully tested at the factory. The basis of acceptance of the tube in the factory is: proper range of and consistent amplification, lack of microphonic action, and perfectly steady base line. For this reason replacement of the tubes with those available locally cannot be authorized.

UNSTEADY BASE LINE - When the tubes are good, the beam should remain motionless as observed on the calibration scale with the lead selector on position "S", the sensitivity control set for 10 mm. amplification, and, the instrument fully stabilized. Faulty tubes may cause a flicker in the base line which is usually slight and seldom exceeds 1 mm. in amplitude as shown in Figure 16. For this reason it is best to take a sample tracing and observe the base line for irregularities. Before attempting the tube unit replacement, investigate other causes known to produce a similar condition. If the difficulty cannot be remedied, replace the tube unit, but do not overlook the fact that the replacement tube unit may also have become faulty while in storage or in transit.

MICROPHONIC ACTION - Widening of the beam on the calibration scale each time the apparatus is subjected to a slight jar or vibration such as is caused by normal handling of the controls is brought about by rapid vibration of the internal elements of the tube. A tube unit exhibiting this characteristic is called microphinic. Close examination of the base line secured on an instrument with microphonic tubes will reveal rapid oscillations of an order of approximately 100 per second. If the tubes are moderately microphonic, this condition will be observed each time the apparatus is jarred; if they are badly microphonic, oscillations will be noted in the base line, even though the instrument is not touched at all. Microphonic tube units should be replaced.

DECREASE OR INCREASE IN AMPLIFICATION - In electrocardiographic practice a calibration which causes a beam deflection of 10 mm. when a potential of one millivolt is impressed across the input terminal of the instrument is accepted as standard. The Model B Electrocardiograph is, therefore, guaranteed to produce this amount of deflection on standardizing. In unusual cases a lower beam deflection of 5 mm. or higher deflection of 20 mm. may be desired. Although these limits are not guaranteed, this range of amplification can be secured.

Occasionally, the amplification of the tubes may change after a period of use. If the amplification is less than 15 mm. on the maximum setting of the sensitivity control, the amplification is too low. On the other hand, if the deflection is more than 10 mm. on the minimum setting of the sensitivity control, the amplification of the tube unit is high. If either of the conditions is observed, the tube unit replacement is advisable. Remember, however, that excessive amplification may be caused by faulty B batteries, open-circuited sensitivity control, or faulty amplifier pack, whereas low amplification may result from low batteries, leakage in terminal strips or tube unit due to humidity, faulty amplifier pack, and defective galvanometer.

VARIABLE AMPLIFICATION - Faulty tube unit may cause a variable amount of deflection when the standardization switch is operated several times in succession without changing settings of the instrument. If variation or consistent decrease in the standardization deflections occurs over a period of time normally required for taking one tracing, the tubes are probably faulty and must be replaced.

The test should be performed using a fresh set of batteries, as excessive and rapid drop in voltage of the batteries that are not fresh may cause a drop in amplification over a reasonably short period of time.

DIP IN BASE LINE - It is a well known fact that on the amplifier type Electrocardiograph application of the standardization voltage causes the base line to jump to the peak of the deflection and to begin to decay. Removal of the standardizing voltage produces downward decline to the original level. If however, the standardizing voltage is applied for a very short time, the base line should jump to the peak of the deflection and immediately return to the original level. It is obvious that low-acting standardization switch would cause the base line to dip a slight amount on completion of the standardization excursion.

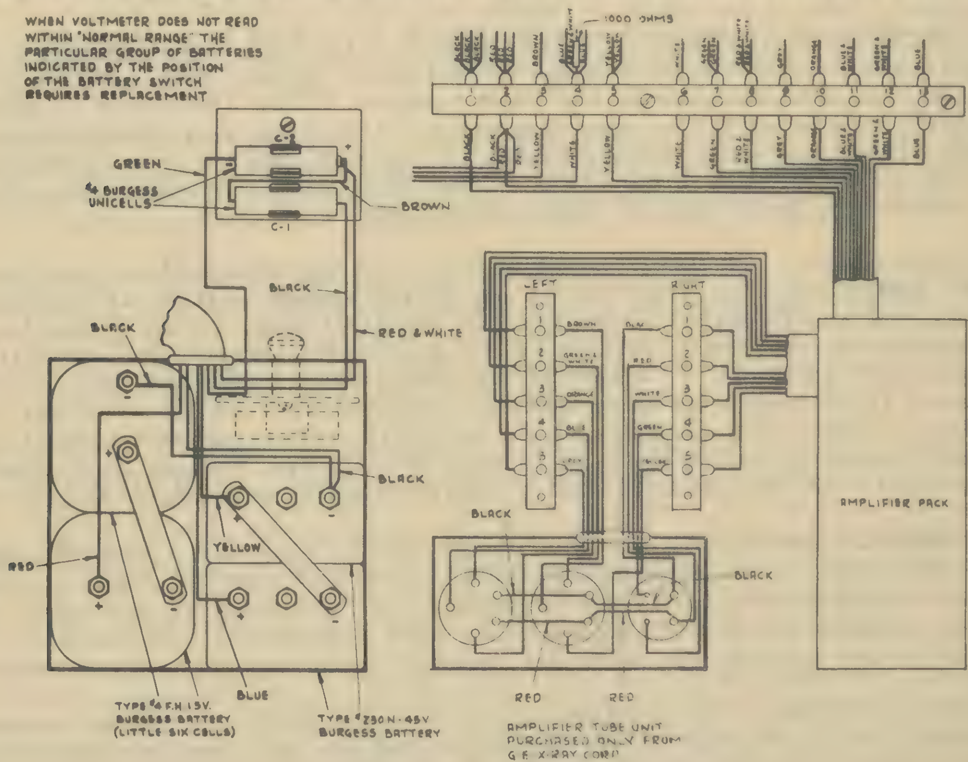
UNSTEADY BASE LINE
FIG. 16

EXCESSIVE DIP IN BASE LINE
FIG. 17

On the push-button standardization switch, the contact closing time can be made longer without causing the dip in the base line following the downward stroke of the standardization mark. However, if it is pressed for a longer time than 1/10 second, the dip will occur.

With quick tapping of the push-button type switch, the base line dip of not more than 1/4 mm., may be considered normal. If, however, a greater dip occurs, as shown in Figure 17, the tube unit is probably responsible. Under these circumstances, replacement of the tube unit may be desired.

SLURRING OF BASE LINE - Slurring (thickening) and slow resolution of the downward stroke of the standardization mark near the base line is a condition



BATTERY, TUBE UNIT, RESISTOR-CAPACITOR PACK, AND TERMINAL STRIPS - FIG. 19

opposite to that just described. This is shown in Figure 5. A similar condition can occur because of improperly adjusted standardization switch, examination and adjustment of this device should be made first if necessary. If slurring is not eliminated, the tube unit may be suspected.

INTERNAL DEFECTIVE CONTACT - It is possible for one of the internal con-highly irregular action of the beam as observed on the calibration scale. Replacing the tube unit will quickly prove if the original unit was at fault.

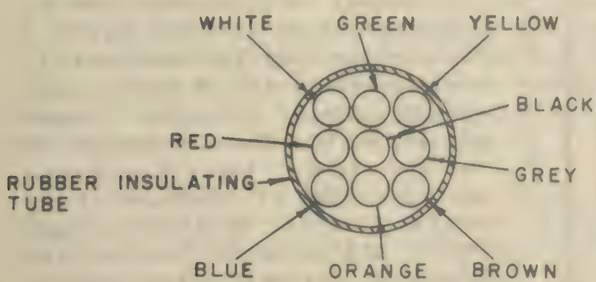
BROKEN OR BURNED OUT FILAMENT - If the filament in any one of the tubes is broken or burned out, the beam could not be made to deflect on standardizing or recording heart action. If the filaments are damaged, the voltmeter reading will be high even though the filament control is turned to minimum setting. Failure of one or more filaments requires the replacement of the complete tube unit.

TUBE UNIT REPLACEMENT - If the replacement of the amplifier tube unit is indicated, remove the metal guard over a single terminal strip utilized on Type 1, and two terminal strips used on Type 2 and 3 Model B Electrocardiographs. Unsolder the leads coming from the tube unit. Loosen the thumb nut on the metal case containing the tube unit and remove the cover. Remove the tube carton containing the old tubes and insert the carton containing the new tubes. Solder the leads from the new tube unit to the terminal strips, matching the colors of the leads with those remaining connected as shown in Figure 19. Restore the cover on the metal case and the guard over the terminal strips.

RESISTOR-CAPACITOR PACK (AMPLIFIER PACK) - The resistor-capacitor pack contains patient's resistances, grid and plate resistors, condensers, and high and low standardization resistances, all sealed in wax.

The resistor-capacitor pack is mounted on the back cover next to the tube unit. An 11-conductor cable connects the pack to the upper terminal strip. This method of mounting eliminated resistor-capacitor pack to tube unit connecting cable with which some difficulty was experienced due to twisting of conductors.

REPLACING RESISTOR-CAPACITOR PACK - Unsolder the wires of the two cable from the upper and lower terminal strips. Set the instrument on a bench with the galvanometer end down. The Electrocardiograph should be placed on a pad of soft material to avoid damage to the finish. Remove the two screws holding the track along which the drawer slides and remove the track. Now remove the two screws immediately below the pack. Put the new amplifier pack in place and fasten it securely by means of screws. Replace the track-making sure that the drawer fits properly into the grooved section. Then resolder the leads using a rosin core solder. Follow Figure 19 to avoid error in connecting the wires to the terminal strips.



RESISTOR-CAPACITOR PACK TO TUBE UNIT CABLE ARRANGEMENT
FIG. 20

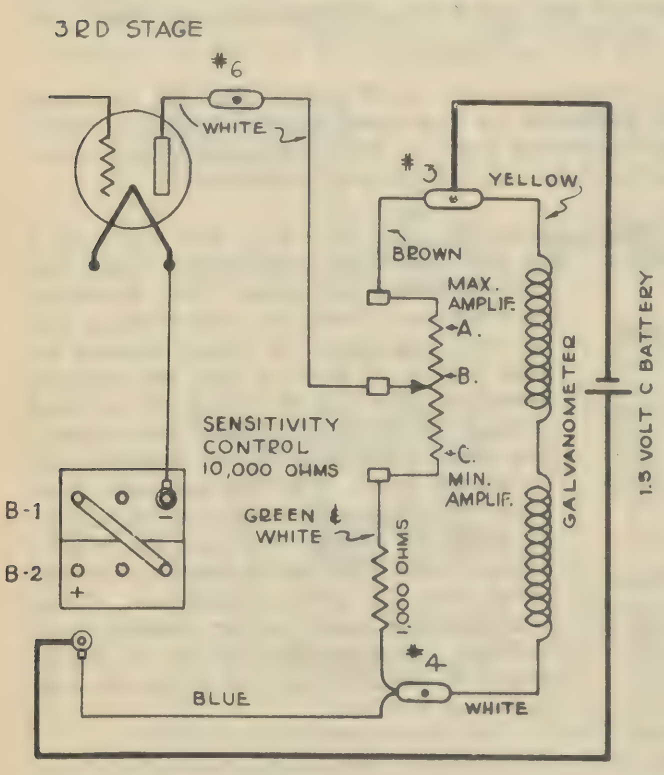
GALVANOMETER - The galvanometer internal working parts are completely encased in a metal container and are immersed in a special transparent oil which is

used for damping purposes. An air space is left to allow for oil expansion. Should fault develop in the internal parts, do not attempt repairing the galvanometer, but order a replacement. As the galvanometer proper is matched with a permanent magnet, a complete galvanometer assembly will be sent for replacement.

BEAM CONTROL NOT POSITIONED PROPERLY - The direction in which the mirror in the galvanometer faces is determined by the position of the permanent magnet suspended about the outside of the galvanometer. This magnet is moved by means of the beam control on the panel. Should the beam control knob slip on the shaft, the beam will not be in the center of the sensitivity scale even though the beam control knob is in the central position.

Turn on the instrument and allow one minute for stabilization. Turn the beam control indicator until the beam rests in the center of the sensitivity scale. If the white line on the beam control does not coincide with the center line on the nameplate, reset the control knob.

GALVANOMETER MIRROR TURNED AND STICKING TO ONE SIDE - On some occasions the mirror when deflected far to ine side may stick and stay in this position. When this occurs, movement of the beam control will not change the position of the mirror. Tapping of the galvanometer case with the finger will usually serve to loosen the mirror. If this difficulty cannot be remedied, or if it occurs, it is best to effect the galvanometer replacement.



GALVANOMETER TEST
FIG. 21

OPEN CIRCUIT - No deflection from heart action or when operating the standardization switch will occur if the galvanometer is open-circuited. The same manifestation of trouble can, however, occur due to fault elsewhere in the circuit. Hence, the description of a method for determining whether the galvanometer is open-circuited.

Secure 1½ volt cell such as C battery used in the Model B Electrocardiograph and solder leads approximately 8 inches long to each pole of the cell. Remove the lead from the terminal of the B-2 (lower) battery and connect it to one of the leads of the battery cell. Turn on the main switch and bring the beam to the center of the calibration scale. Now close the circuit through the galvanometer by connecting the other lead of the C battery cell to the #3 terminal; The beam should deflect approximately 15 mm. and remain in the new position as long as the circuit remains closed. If no deflection occurs, thegalvanometer is open-circuited, and should be replaced.

Figure 21 shows in heavy lines the method of connections for making this test. The numbered terminals are the terminals on the upper terminal strip with #1 on the extreme left when looking at the terminal strip from the back of the instrument as shown in Figure 19.

GROUNDED GALVANOMETER - When the galvanometer is grounded, it will not be possible to make the mirror face straight forward by turning the beam control. Consequently, the beam could not be brought into view on the sensitivity scale even though the beam control is moved from one extreme to the other. When this condition is observed, loosen bearing clamps and tilt the galvanometer so that its top can be examined. Inspect for metal chips, pieces of solder or dirt between either terminal post and the galvanometer case. If no external trouble is found, the galvanometer is grounded internally requiring replacement. As the galvanometer ground puts a heavy drain on the B batteries, it is quite likely that the batteries will be found partially or completely discharged. It may therefore be necessary to replace the battery when changing the galvanometer.

A diagnosis of galvanometer or sensitivity control ground can be verified by disconnecting the lead from + terminal of B-2 (lower) battery and noting if the beam can be brought to the center of the calibration scale. Another method is to connect a D.C. milliammeter in series with + terminal of B-2 battery. When the equipment is in the proper operating order, turning on the main switch causes an initial deflection of approximately 8 MA. which then drops to zero and gradually rises to approximately 3 MA. This corresponds to the completion of the stabilization period of the instrument. If the galvanometer is grounded, considerably higher reading on the milliammeter will be obtained.

Occasionally a ground may be of intermittent nature. The instrument may therefore operate at times satisfactorily whereas on some other occasions it will not be possible to bring the beam into view on the sensitivity scale because of ground. If the galvanometer is at fault, it should be replaced.

LOOSE GALVANOMETER COIL - This condition is very rare. It is obvious that movement of the galvanometer mirror will be restricted if the coil lies against it. As a result, small amplitude of deflection will be produced when standardizing the equipment. Furthermore, the deflection will be considerably distorted because of the restriction in the movement of the mirror. The best method for testing this condition is to turn the beam control over its entire range and note if the illuminated field containing the beam moves in unison with the rotation of this control. If the beam stops and cannot be moved beyond a certain position as the beam control is continued to be turned, the difficulty probably lies in loosening of the coil. As this condition cannot be remedied in the field, a replacement galvanometer should be installed.

LOOSE MAGNETIC VANE - If the magnetic vane loosens from the string inside the galvanometer, the beam will not deflect from heart action or when operating the standardization switch. Furthermore, the beam will remain stationary when rotating the beam control either way. This condition occurs very seldom.

LOOSE MIRROR IN GALVANOMETER - If the mirror becomes partially detached from the string, it will not be possible to center consistently the reflected light from the galvanometer on the sensitivity scale. If the mirror is completely detached, manipulation of the beam control will have no effect upon it. Depending on the position of the detached mirror, the reflected light may or may not appear on the sensitivity scale. This difficulty is seldom encountered.

GALVANOMETER LEAKING OIL - Leakage of oil from the galvanometer can be easily recognized by merely observing the galvanometer assembly and noting if there is any oil directly under the galvanometer. The oil leakage may occur at the top of the galvanometer, at the glass window, at the work gasket where the galvanometer window assembly is screwed into the cylinder, or in the cylinder proper. The safest procedure to follow is to effect the galvanometer replacement irrespective of the site of the oil leakage.

POOR CONTACT IN GALVANOMETER - The working elements of the galvanometer are sealed in oil and therefore poor contact in the conducting circuit will seldom occur. When poor contact is present in the galvanometer, the base line will exhibit intermittent fluctuations. The ohmmeter method may not be entirely satisfactory because the poor contact in the galvanometer could be of intermittent nature. In order to check this condition by the ohmmeter method, remove the lead from the terminal of B-2 (lower) battery and connect the ohmmeter leads in place of the C battery cell as shown in Figure 21. The best method is that of process of elimination, namely replacement of the galvanometer.

REPLACEMENT OF THE GALVANOMETER - When removing the galvanometer for examination or for replacement purposes, take out the camera and remove the front plate held by four screws. Loosen the screws on the bearing clamps and rotate and galvanometer shell so as to gain access to the terminal posts. Unsolder the wires from the terminal posts. Next, remove the two screws which secure the galvanometer assembly to the side partition on the instrument. Follow the reverse procedure for installing a new galvanometer, consulting the instructions covering the adjustment of the optical system for correct alignment of the galvanometer mirror.

PATIENT'S CABLE - The cable connecting the patient to the instrument is of special construction designed to reduce external interference pick-up and is selected for flexibility and durability. When the instrument is not in use, the cable is kept in the drawer in the bottom of the unit. As the space available in the drawer is limited, some difficulty may be experienced in storing away the cable. It is suggested that all the accessory items be first removed from the drawer and the cable fashioned into a coil and positioned in the drawer. The accessary devices can then be placed to fill up the space available. This simple procedure will avoid cramming the cable and accidental catching of the leads between the drawer and the instrument.

A question may arise if the cable can be tested on location without the use of special testing equipment. The test can be mad by holding firmly together or clamping the three cord tips of the cable, then changing the lead selector switch to leads 1, 2, and 3, in meantime noting the behavior of the beam on the calibration scale. With the three cord tips connected together, the instrument will operate on patient lead settings in the same fashion as it does on the position "S". During this test, the patient's cord should be flexed and bent over as much of its length as possible. If the beam becomes unsteady requiring a long period of time for it to settle down, quite obviously one of the conductors of the patient's cord is at fault. At this point it is well to remember that the beam will not be stable on patient's lead settings without the patient's being connected. This is a normal characteristic of the instrument and the deflections of the beam should not be interpreted as an indication of trouble.

CONDUCTOR BROKEN PARTIALLY - If one of the conductors is partially broken or if the insulation surrounding it has been damaged, this condition will usually be manifested by erratic action of the beam on two of the three patient lead settings. This is due to the fact that only two of the three conductors are used

at any one time, and for one setting of the lead selector the damaged conductor will not be in the circuit. In the event that two conductors are damaged, erratic action of the beam will be noted on all three leads.

CONDUCTOR BROKEN COMPLETELY - If one of the conductors is broken completely, no deflection due to heart action will occur on two of the three patient lead settings. The beam, however, will be unstable as it oscillates on lead selector positions 1, 2, and 3 without patient's being connected or with patient connected but with one lead broken. If the conductor is broken inside the cable, a new patient's cable should be installed. On the other hand, if the break is near the metal cord tip, the broken sections of the conductor can be removed and connection made by soldering the conductor end to the cord tip.

GROUNDED PATIENT'S CABLE - The instrument end of the patient's cable is permanently fixed. On entering the drawer this cable is led upward along and held in place by means of two clamps to the side member. The metal sheath is grounded to the instrument at the upper clamp. From this point the three conductors pass over the center partition and are soldered under lead selector switch. These wires are so positioned at the factory that they do not come in contact with the spring motor revolving drum. Occasionally one of the wires may come in contact with the drum. Continuous rubbing against the drum may cause wearing out of the insulation and intermittent grounding of the lead.

When this condition is present, the base line will remain steady on standardization and patient leads as observed on calibration scale before the motor is turned on. Turning on the motor will cause the beam to become erratic. To overcome this difficulty, it will be necessary to remove the top panel of the instrument, insulate the lead, and reshape it so that it does not lie against the revolving drum.

REPLACEMENT OF THE PATIENT'S CABLE - In order to effect replacement of the patient's cable, the top panel, the upper and lower clamps attaching the cable to the instrument, and the casting supporting lead selector and battery test switch must be removed. Then unsolder the leads of the old patient's cable one at a time, soldering in the meantime the corresponding lead of the new cable. These leads can be identified by colored bands painted on the insulation. After the leads are soldered, replace the casting and fasten the cable to the instrument by means of the two clamps. The leads should be shaped to prevent the leads coming in contact with the motor drum. Be sure to ground the lead connected to the metal sheath of the cable at the screw which fastens the upper clamp in the instrument.

INTERFERENCE - The general term "interference" has been applied to oscillations other than those originating in the patient's heart superimposed upon the heart record. These extraneous deviations make the electrocardiogram less valuable as a means of diagnosis and if present to an appreciable degree, may render it quite useless.

It must be remembered that the Electrocardiograph is a very sensitive precision instrument capable of recording faithfully very slight changes in the heart potential. Hence, it will respond to the effects of induction current if brought close enough to the interfering source or to the influences of muscle convulsions when the patient is not sufficiently relaxed or the electrodes improperly applied.

Electromagnetic and electrostatic induction is the most common and often erroneously considered the only cause of interference. While most interference

is caused through induction from neighboring electrical apparatus and supply circuits, other sources should not be disregarded because they may also contribute to the distortion of the heart record and may frequently be mistaken for interference arising from electrical sources.

These are many individual sources of interference and most of them may be classified ur 'er the following broad divisions:

ELECTROMAGNETIC AND ELECTROSTATIC INDUCTION - Electromagnetic induction is produced through a magnetic phenomenon which is associated with the current actually flowing in the electrical circuit. Electrostatic induction, on the other hand, takes place regardless of the current flow; thus, it may originate from a circuit which does not carry any load. The electromagnetic or electrostatic field surrounding the electrical circuits must be variable in strength in order to set up interference in the electrocardiograph. A steady direct current line would have no effect because of the type of circuit employed in the electrocardiograph. Of course, if a change in the direct current flow occurs, the field of force surrounding the D.C. line also varies and may become a potential source of interference.

Recognition of interference can be accomplished by observation of the beam on the calibration scale. With the lead selector on position "S", observe closely the width of the beam appearing on the calibration scale. Move the selector to positions 1, 2, and 3 with a patient connected, and as soon as stabilization of the apparatus is completed note if the width of the beam has increased. This widening of the beam is caused by deflections so rapid that the eye cannot distinguish each separate movement. If these deflections are not too large, deviations of the beam due to heart action will still show. Lack of interference on lead "S" is explained by the fact that the instrument proper and the connecting cables are adequately shielded and the patient is not in the circuit. On leads 1, 2, and 3, the patient is placed across the input terminals of the electrocardiograph and acting as an aerial picks up the interference. Should the electrocardiograph be brought very close to the interfering source or when the source is very powerful, the deflections of the beam on the calibration scale may be of such magnetude as to lead one into believing that the apparatus is defective since no beam is visible. A strong source of interference may cause deflection of the beam even when the lead selector is on "S". If a tracing is made under this condition, complete distortion of the heart record due to interference will result.

Although interference can be detected by observation of the beam in the manner just indicated, the type of interference can only be ascertained by studying the finished tracing. The oscillations caused by different sources of interference are characteristic and it is often possible to learn from the study of the tracing what the offending source is. The interference caused by power and light circuits consists of smooth, regularly occuring back and forth waves superimposed upon the heart record. It is characterized by constancy of frequency and equal heights of the resulting oscillation. Full wave valve rectified x-ray and high frequenc apparatus will produce similar type of oscillation. Oscillations from half-wave or self-rectified apparatus will show an appreciable thickening on one edge and sharp peaks on the other edge of the oscillations. The heights of the waves induced from the mechanical rectified x-ray and spark gap high-frequency machines may vary, but the waves will be equally spaced and show decided regularity which leaves no doubt that they are set up by action other than that caused by the heart or lack of muscle relaxation on the part of the patient.

There are many sources of interference, and any nearby electrical circuit or

apparatus should be considered as a possible source. The list of sources indicated below is quite complete, but it must be stressed that when interference is present, one should be alert for extraordinary causes and conditions.

Alternating and direct current power and lighting circuits.
Alternating and direct current electrical machinery.
Spark gap and tube type high frequency apparatus.
Full, half and self-rectified x-ray apparatus.
Telephones, telephone wiring and trunk lines.
Elevators.
Electrical buzzers and bells.
Drop lights, reading lights and extension cords.
Patient signal cords on push-buttons.
Fan motors.
Bed heaters.

Whenever interference is present, it usually can be eliminated by one of the following methods:

LOCATING AND TURNING OFF THE OFFENDING SOURCE - Location of the interfering source is usually accomplished through the process of elimination. All light switches in the room must be turned off, drop cords, extension cords and all other wiring should be, if possible, removed from the receptacles. The instrument should be kept away from walls in which the electrical wiring may be concealed. If this preliminary procedure does not stop interference, the fuse box for the room should be ascertained and the fuses removed when taking a tracing.

MOVING PATIENT AND APPARATUS AWAY - If turning off the source of interference is not possible, the apparatus and the patient must be moved far enough away to be out of interfering field. This can be accomplished by moving the apparatus and the patient to a different location in the same room or to a different room. This method may offer difficulties because some patients cannot be moved and in some instances moving away from one field of interverence only results in moving into a new source.

PARTIAL SHIELDING - Relief from the interference can at times be secured by interposing #16 mesh galvanized iron metal screen between the patient and the interfering source. Grounding should however, only be effected if there is a good earth ground of low resistance. A poor ground is apt to increase the disturbances. Placing a 3' x 6' sheet iron or galvanized wire screening under the mattress and grounding it to a good earth ground may at times prove successful in combatting interference.

COMPLETE SHIELDING - When turning off the interference at its source or moving away from its field cannot be done, then shielding of patient, apparatus and operator is the only solution. A shield may be constructed by erecting a light framework of wood and covering it on all four sides, top, and bottom with 16 mesh *galvanized* iron wire screening. Apparatus, operator and patient should be at least six inches away from the screen. The shielding booth must not be placed right next to an x-ray or high-frequency department. A distance of at least 15 feet between x-ray, high-frequency apparatus or other powerful electrical apparatus and the shielding booth should be maintained. This procedure must be followed since strong interference may even penetrate the shield.

While the shielding booth may be constructed of any convenient size sufficiently large to accommodate the patient, apparatus and operator, the Engineering Service

Department have available complete plans and construction data for building booths of two different sizes. The smaller booth is 5' long, 3-1/2' wide and 6' high while the large booth is 7' long, 5-1/2' wide and 6' high. In the former the patient can be located in a sitting position and the latter is large enough to accommodate the patient on a cot.

The screening must be complete. In other words, the construction must be such that a screen barrier is present from any direction. Open cracks and tears may destroy the effect of the shield. All joints should have a lap of approximately 1-1/2" and a strip of solder running along the lap to insure good contact. The door should be so constructed that a good contact by lapping and pressure is made. A wood floor or some other covering should be used to keep the feet of the operator and patient at least 2" from the screening.

Grounding of the shield may or may not be necessary. To determine this a record with and without a ground wire connected should be made. If groundings indicated, the ground wire should be connected to a cold water pipe. The use of several ground wires attached to the different parts of the shield may sometimes improve results.

PATIENT - A good electrocardiogram from a technical standpoint should be free from influences of somatic tremor or muscular convulsions, a postulate which not always can be fulfilled.

SOMATIC TREMOR - Somatic tremor causes deflections superimposed on heart tracing that might frequently be mistaken for electrical interference. The best way to distinquish this form of distortion from that caused by electrical action is to examine the tracing closely for regularity of wave shape, length and height. It will be noticed that the waves are irregularly spaced, usually of variable height not exceeding 2 mm. and are of different shapes. This is quite different from electrical interference which produces oscillations of regular wave lengths and shapes.

BREATHING - Another form of disturbance occasionally produced by a patient is a gradual rise and fall of the base line. This is a result of breathing and cannot readily be overcome. Changing the patients will quickly reveal whether the condition is caused by the patient or instrument.

"PARALYZED BEAM" - Strictly speaking this is not interference; mention of this phenomenon is made here because it is caused by the patient. You are familiar with the fact that during the stabilization period following turning on main switch the beam does not deflect when the standardization is operated. "Paralyzed beam" is not a dissimilar condition. It is caused by skin potentials of certain polarity. These potentials may reach 40-50 millivolts in magnitude, are usually of direct current nature, and may be positive or negative. When applied to the instrument, they cause blocking action.

This condition is manifested as follows: Deviations due to heart action are observed after the lead selector is changed to one of patient's lead positions, but they then diminish in amplitude or even cease entirely. After 10 or 20 seconds the beam deflections are resumed and gradually come up to maximum amplitude. The stabilization time between the leads may be lengthened from 10 seconds to 40 seconds, depending on the magnitude of skin potentials. All that is necessary is, allow longer time for stabilization when such condition is encountered.

Thorough investigations made to find out methods to eliminate distortions occasioned by somatic tremor proves that the following precautions are necessary before taking a tracing.

PREPARATION OF PATIENT - Before running a tracing the patient should be allowed to rest comfortably in a sitting or lying position for at least a quarter of an hour. It is of great importance that the patient does not feel cold. Therefore, the air in the room should be warm and electrodes not too cold. If the patient appears to be afraid or is distracted by noise or bustle in the office, the tracing is likely to become distorted. This also may be the case if the patient wants to urinate. Hence the patient must be thoroughly relaxed and fully at ease in a quiet room without spectators.

ELECTRODES - It is very important that the electrodes be properly attached to secure a satisfactory tracing. Apply a small amount of paste from the tube to the skin areas selected. Rub the paste vigorously into the skin for 5 to 10 seconds, longer if skin is hairy or tough. Apply additional paste and spread evenly over the rubbed area. Fasten the electrode with the rubber band firmly but not too tightly. If the band is pulled too tightly the muscles will become constricted. The action currents will be set up causing somatic tremor. On the other hand, if the electrodes are bound too loosely, poor contact may result with consequent uneven base line on the tracing.

The electrodes should be kept clean by rinsing in warm running water. Failure to observe this precaution may cause corrosion and local electrochemical action which may produce quiver in the base line.

POSITIONING PATIENT - The electrocardiogram may be made with the patient either in sitting or reclining position. A majority of patients can relax more fully when lying down, but any position is satisfactory as long as the patient is able to relax completely. As all voluntary movement or muscular effort of any kind is prohibited it is essential that the patient be in a comfortable position and perfectly relaxed. The patient's hands should not touch each other and legs should not be crossed. Arms and legs should not be excessively flexed or complete relaxation could not be attained. Care must be used that no constriction of the extremities occurs when the patient's clothing is rolled up.

There are a few people who, in spite of all sorts of precautions, produce distorted tracings on all the leads. These are shell-shocked, seriously nervous or chorea affected people. It may happen that distortion present in lead 1 will decrease or disappear in the other two leads. This especially applies to the people engaged in manual labor which requires the use of their arms. It is quite obvious that their arm muscles tremble. In the case of patients suffering from labored breathing, who cannot lie still, the tracing should be taken with the patient in a sitting or semi-reclining position.

MECHANICAL SHOCK AND JARRING - Distortion of the tracing induced by mechanical action rarely occurs and because of its rarity frequently baffles even the more experienced. These deflections may be intermittent or continuous, depending on the nature of the source.

When the tracing is being actually made the apparatus and the patient's cord should not be moved. The deviations caused by movement can easily be recognized as they are of intermittent nature, not characterized by uniformity and regularity of action, and disappear when the instrument is correctly operated.

Deviations of the beam other than those produced by the heart action may occur if the instrument is jarred and the standardization switch and lead marker are not handled gently. Instruct the operator to refrain from resting his hands or elbows on the instrument and not to touch it when the tracing is actually recorded.

STATIC CHARGE - Accumulation of static charge by the operator may cause momentary deflections of the beam whenever the instrument is touched. It is most likely to occur in carpeted rooms where temperature is high and humidity low - a condition which is likely to arise in winter time. Dissipating the static just before operating the instrument by placing the arm on grounded object such as cold water pipe or radiator will aid materially in preventing this type of disturbance. A more positive method, however, is to avoid touching the instrument or operating the lead marker once the motor switch is turned on for recording of standardization and patient's leads.

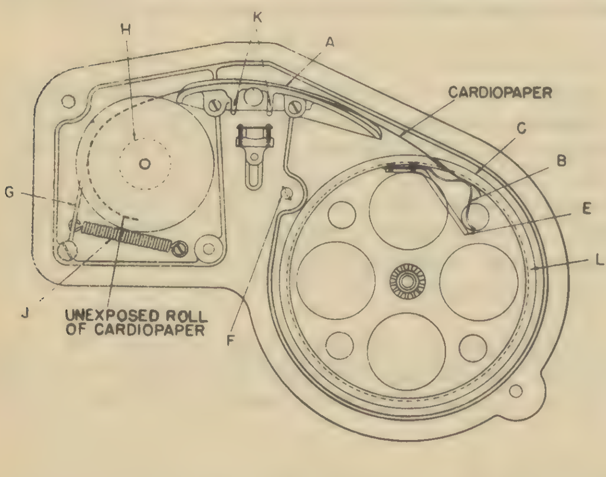
MECHANICAL ADJUSTMENTS

The mechanical adjustments described herein cover the camera and the motor unit. Other adjustments of a mechanical nature are not mentioned because they are too obvious to require service instructions.

CAMERA - The camera in the Model B Electrocardiograph is removable, permitting its detachment from the instrument when carrying it to and from the darkroom and is designed to use 45 mm. cardiopaper. Not more than 20 feet of cardiopaper should be exposed at any one time. Running more than 20 feet of paper may cause difficulty by forcing too much paper on the receiving spool and may introduce a slight error in the time line recording.

The camera consists of the camera proper, Figure 22, and the camera cover. For identification of various parts mentioned in this section, refer to this sketch.

PROPER METHOD OF LOADING AND HANDLING CAMERA - As there is no shutter on the camera window, the light enters the camera through the window while carrying the camera from the loading bench and when the instrument is stabilizing. The shutter is unnecessary provided the camera is handled properly.



CAMERA PROPER
FIG. 22

If the camera is loaded so that the cardiopaper is not tight against the slide A, the light entering through the camera window will pass through the slot in the slide and fall upon the emulsion side of the paper. The light reflected from the paper will then illuminate the polished surface of the slide which in turn will cause fogging of several inches of paper. The standardization mark and beginning of the lead 1 will fall on this portion of the paper, therefore obliterating them.

The correct way of loading the paper is to pass its free end under the clip B of the take-up drum C, turn the take-up drum about an eighth of a turn in a clockwise direction noting if the paper falls squarely between the rims of the drum and realigning the paper under the clip, and then rewinding the cardiopaper on the unexposed roll by turning the roll backward as far as it will go without tearing the paper or pulling it out of the spring clip. This will bring the slot in the

take-up drum as close as possible to the end of the slide A, as illustrated in Figure 22, and will hold the paper taut against the slide. Under these conditions, only a small area corresponding to the size of the slot in the slide will be exposed.

As the paper may not be fully tight against the slide, it is suggested that the motor be turned for an instant after the camera is attached to the instrument and before turning on the main switch. This method will cause a waste of perhaps 1/2-inch of the paper, but on the other hand, it will prevent the loss of several inches of paper which otherwise may become fogged if the paper is slack.

Even though the camera is properly loaded and the paper is tight against the slide, fogging of exposed paper collected on the take-up drum and of several turns of unexposed paper in the fresh roll chamber may result if the camera is subjected, even for a short time, to a very strong light. This condition also may result if the camera is left outside of the instrument for a long time in subdued light inside the building. It is therefore, recommended that a finger be held against the camera window while carrying it in a sun-lit room or outside and the camera not allowed to remain outside the instrument for a prolonged period of time in subdued light.

When the camera alone is to be transported outside of the building for an appreciable length of time, holding the finger over the camera window may not be practical. In such cases, it is recommended that a small light-tight bag, large enough to accommodate the camera, be employed. An additional advantage of keeping the camera outside of the instrument as little as possible is that accumulation of dust on the various elements of the optical sustem will be prevented. Excessive dust on these elements will cause light tracings or whitish streaks along the records.

PAPER SLIPS FROM UNDER CLIP - If paper slips from under the clip, no record will be made even though the motor is in motion. This condition is very unlikely to occur.

BENT FRICTION LEVER AND EXCESSIVE FRICTION - The function of the lever G is to provide some friction on the cardiopaper. This lever should bear on the roll of cardiopaper with equal pressure along its edges. If the lever bears on the paper with only one edge, the paper will tend to travel in a corkscrew fashion. This will prevent the paper from laying flat over the slide and will cause fuzzy rendition of the timing lines on one edge of the paper. This may also contribute to the paper's climbing on the ridge of the slide, and result in improper transport of the paper in the camera. To make certain that this lever is straight, allow it to come in contact with the metal spool H. The lever should touch the spool on both sides. If this is not the case, bend the lever until this requirement is fulfilled.

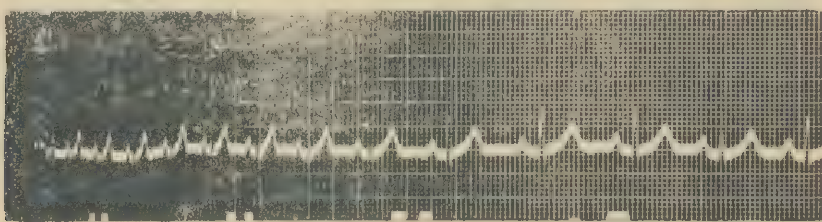
If the tension of the spring J is excessive, the motor may be slow in starting or the speed of the paper travel may be intermittently impeded. It is doubtful that such a condition will arise frequently, but in the event it is experienced all that is necessary is to stretch the spring J a slight amount.

MOTOR UNIT - The spring motor unit drives the paper in the camera and provides motive power for the time marking device. The motor is equipped with a governor of almost instantaneous action. It is initially adjusted to within a fraction of one percent accuracy and should remain in adjustment over a long period of time.

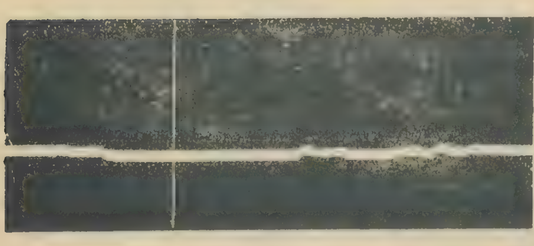
Since the time marking wheel is mechanically coupled to the motor, the spacing of the timing line will be the same during the period the motor is coming up to speed as it will be during the period it is running at normal speed. It is obvious, therefore, that the heart cycles will appear closer together as the motor is gaining speed. For this reason, the time line markings cannot be used as a measure of the time intervals during this period. It is customary, therefore to disregard the first inch or two of each lead tracing. It will also be noted when examining the tracing that the background is somewhat darker than after the motor gains its normal speed.

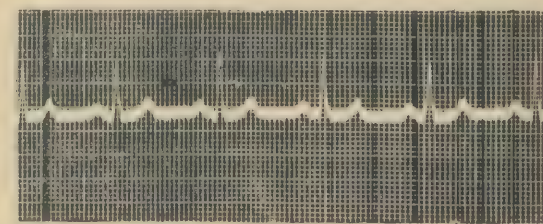
Inasmuch as accurate reproduction of time line markings depends on the accuracy of the paper driving motor, the motor has been designed with an inherent error of less than one percent. Furthermore, means are provided for definitely checking the speed of the motor at any time.

The types and number of motor difficulties are few. Therefore, when the motor starts slowly, stops after starting, or changes its speed, do not blame the motor without first investigating alignment in the camera. The motor does not require any oiling or greasing, nor any maintenance or adjustment service with the exception of occasional checking and adjustment of the motor speed.



MOTOR SLOW IN STARTING
FIG. 23





DARK AND LIGHT STREAKS AND IMPROPER REGISTRATION OF TIME LINES

FIG. 24A

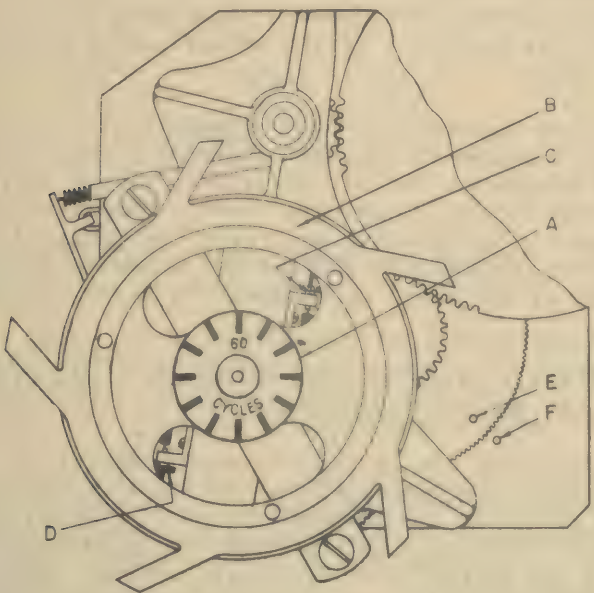
FIG. 24B

CHECKING AND ADJUSTING MOTOR SPEED - Two methods of checking motor speed are provided, both simple and accurate. Where alternating current of uniform frequency divisible by 5 is available, the stroboscopic method is recommended. Where suitable alternating current is not available, or the building is supplied with direct current only, the timing may be checked by means of a stop watch, counting the number of revolutions of a marked gear within a certain period of time.

When checking timing, it is essential that the camera be loaded in position, since the purpose of checking is to determine the rate at which the cardiopaper is passed through the camera; not the rate at which the motor moves without this load.

To save the paper, leave the main switch in the "OFF" receptacle and rewind the paper on completion of test.

STROBOSCOPIC METHOD - The stroboscopic method of testing requires the use of a small neon glow lamp supplied with equipment. This lamp should be screwed into an ordinary electric light extension cord which is then connected to the line. The neon lamp supplied with equipment is designed for use on 115 volt electric circuit. Be sure that the frequency marking on the stroboscopic disk corresponds with the frequency of the line.



TIMING LINE DEVICE
FIG. 25

When the stroboscopic disk is illuminated by means of the neon glow lamp, the bars on the disk will appear to stand still or move slowly in one or another direction. When the motor speed is correctly adjusted, the bars will remain stationary. They may drift slightly forward and then backward, but their relative position will remain unchanged. If, on the other hand, the bars appear to move clockwise the motor is running fast. If they appear to move counterclockwise, the motor is slow.

To change the motor speed, turn the timing disk B to approximately the position shown in Figure 25. Turn the upper knurled nut C to the right to slow down the motor, or to the left to speed it up. Now turn the timing disk one-half revolution so that the knurled nut D is brought into approximately the same position as the nut just adjusted. Turn the second nut in the same direction and approximately the same number of turns as were made on the first nut. Check the adjustment, using the neon lamp until the bars of the stroboscopic disk will appear stationary.

STOP WATCH METHOD - Where only direct current or an alternating current of a frequency other than specified above is available, the timing may be checked by means of a stop watch (or an ordinary watch with a second hand, if a stop watch is not available) using index marks provided for that purpose. This method involves measuring the time required for the marked gear to make nine revolutions. The time should be 2½ minutes. The red index mark E is placed on this gear, and another mark F is placed on the motor frame as shown in Figure 25, for convenience in noting the number of revolutions.

If the motor speed is not correct, adjust the knurled nuts C and D as specified above. A preliminary check can be made by measuring the time required for three revolutions of the marked gear which should be 50 seconds.

BROKEN SPRING - The steel spring in the motor drum may break if the winding crank is forced after the spring is fully wound. If the spring breakage occurs, a new motor should be installed. Replacement of the broken spring in the field

is not recommended. First, the element of personal damage is present, and second, the teeth in the gears may be damaged, which will interfere with satisfactory operation of the motor. When this difficulty is experienced, replace the entire motor assembly.

MOTOR BINDS, STOPS, OR VARIES IN SPEED - Difficulties of this nature caused by a motor are not likely to be encountered often. When the motor is suspected, ascertain first for freedom of time line wheel movement. One of the time line blades may be found striking the galvanometer lamp socket cable or housing, catching on one of the set screws in the governor assembly, or rubbing on the side of the recess of the casting through which the winding shaft passes. Reshaping the cable, moving the lamp housing slightly away, or bending a little the offending blade of time line wheel are the necessary remedies.

Variation in the motor speed causing appearance of dark streaks on the record, as shown in Figures 24A and 24B, may be caused by accidental damage of one of the teeth on the gears used in the motor assembly. Similar difficulty will-result if a piece of solder or metal chip becomes lodged between the teeth. When servicing the equipment for one reason or another, be sure not to strike the parts of the motor assembly and do not allow any hard particles to fall in the component members of the motor. If it is found that one of the gears is damaged, the motor assembly should be replaced.

Wearing out of the hole in the brass plate through which the shaft of the intermediate gear passes may also account for this condition.

MOTOR REPLACEMENT - Motor replacement can be made without removal of the top panel. First remove the galvanometer lamp housing from the shaft on which it is positioned. Then remove the two screws on the camera side of the center partition so that the motor assembly will clear the upper terminal strip attached to the casting on which the lead selector and battery test switch are mounted. Lastly, remove from the camera side of the center partition the four flat head screws which hold the motor in place. After these screws are removed, the motor unit can be taken out of the instrument.

OPTICAL ADJUSTMENTS

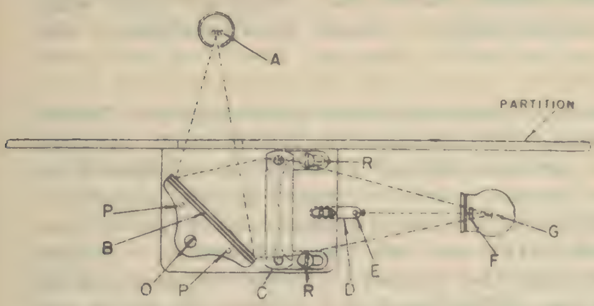
The optical system of the Model B Electrocardiograph has been designed to produce a white tracing on a dark background. This type of recording was preferred in order to utilize an instrument reasonably small in size and light in weight.

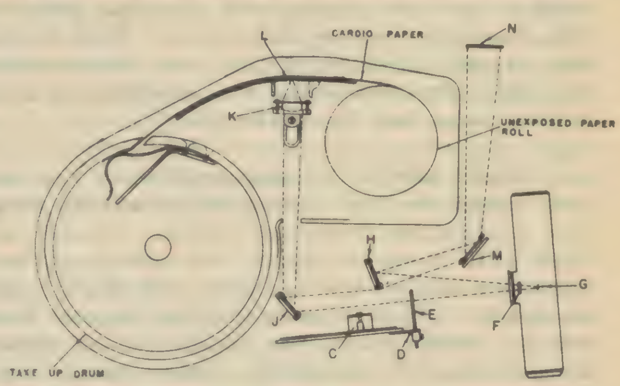
This system can be divided into the optical elements used for incident illumination, and those pertaining to reflected illumination. Figure 26 shows, in plan view, the elements of incident illumination and Figure 27 indicates, in side view, the elements of reflected illumination.

The light originating from the galvanometer lamp A passes through a rectangular opening in the center partition and falls on the 45 degree mirror B. The reflected light is condensed by a double convex lens C and falls upon a small spherical mirror G in the galvanometer. A wire pin E is placed between the center of curvature and principal focus of the galvanometer mirror. Its purpose is to cast a shadow on the mirror G so as to produce the deviations of the beam on the cardiopaper and the calibration window when standardizing or from heart action.

A portion of the light reflected from the galvanometer is intercepted by the lower edge of the first calibration mirror H which directs it to the second

calibration mirror M and then to the calibration window N. The balance of the reflected light illuminates the 45° camera mirror J which directs the light on the camera condensing lens K and through a slot L in the slide onto the cardiopaper.





INCIDENT ILLUMINATION (PLAIN VIEW)
FIG. 26

REFLECTED ILLUMINATION (SIDE VIEW)
FIG. 27

CLEANING AND ADJUSTMENT OF ENTIRE OPTICAL SYSTEM - Because the intensity of light of the illuminating source is of limited value dictated by practical consideration, the optical system must be kept clean and so adjusted that full use of direct and reflected illumination is made.

Dust or dirt, or lack of adjustment of any of the elements comprising the optical system will interfere with obtaining satisfactory tracings or will result in unsatisfactory illumination on the calibration scale. As one or more of the optical elements may be out of adjustment simultaneously, it is nearly impossible to cover every contingency. For this reason, instructions covering complete adjustment of the optical system are given below. When difficulty with the optical system is experienced, all that will be necessary is to check the adjustment procedure step by step until the fault is found. Then the proper adjustment should be made as indicated.

REMOVAL AND CLEANING OF OPTICAL ELEMENT - Remove the camera and the front plate from the instrument. Clean the dust and dirt from the mirrors and lenses, using soft tissue paper. If the mirrors are greasy or finger-marked, a piece of cotton wound around a toothpick and moistened in grain alcohol should be used. Excessive alcohol should be removed by rolling the cotton end of the toothpick on a piece of dry clean cloth. With this, carefully clean the optical elements. Also clean the galvanometer window in the same fashion. If the window is very oily, the procedure should be repeated several times until the oily film is removed. Acetone may be used with care, as it dissolves paint. Do not use, however, denatured alcohol or carbon tetrachloride for this purpose.

Loosen the set screw A Figure 28 in the galvanometer lamp housing and remove the lamp for examination. Remember that even a slight dark deposit on the glass will cut down the illumination sufficiently to require excessively long developing time to secure a tracing of desired density. If the glass is slightly smoky, or if in doubt, replace the bulb. Be sure to wipe the lamp clean before inserting into the housing.

Also remove the condensing lens K in the camera. The set screw holding this

lens in place is under the small oval piece above the thumbscrew used for tightening the camera to the instrument. This lens consists of the lens proper and a piece of glass on which ruling lines are inscribed. The two are fastened together with a special transparent cement. Occasionally, the union between the glass and the lens may become defective. This defect can be readily observed by examining the assembly in good light. If the union has become defective, rings of color will be noted when examining the assembly at a certain angle. Under this condition, the camera lens must be replaced.

Dust particles may settle in the twin condensing lens assembly C. These particles are, at times, difficult to remove. If obtainable, use an air syringe for dislodging these particles. If one is not available, it will be necessary to take this assembly apart for cleaning the lenses. Before removing the assembly, draw a line on the optical bed plate, indicating the original position of the assembly. Then remove the two screws R and lift out the lens assembly. It can now be taken apart for cleaning and examining the lenses. If it is desired to remove the 45° mirror B, first loosen the two Allen head set screws (6-40) P and then remove the screws O.

Also examine the other mirrors for cracks and scratches. These mirrors must be perfectly flat. Occasionally a mirror may become warped, thus interfering with obtaining a satisfactory rendition of the base line, and timing and ruling lines on the tracing. A few cases have been reported of silver lining on the mirrors becoming tarnished or peeled off. Mirrors exhibiting these defects should be replaced.

REASSEMBLY OF OPTICAL ELEMENTS - If it has been found necessary to remove the optical system elements for cleaning and examination, assemble for the time being, the following elements only: condensing lens assembly C, galvanometer lamp A, 45-degree mirror B and first calibration mirror H. Unless their removal was not required, do not mount as yet camera lens K, wire pin assembly E, and second calibration mirror M.

Assemble the galvanometer lamp, loosen the set screw A and rotate the lamp housing so that it is in approximately the vertical position and the rectangular opening in the center partition is in the center of the illuminated circular area. Be sure that the time line disk blades do not hit the housing.

Assemble the double condensing lenses C so that their flat surfaces are flush with the upper metal plate and then restore this assembly so that it occupies the original position as marked on the optical bed plate. In general on newer instruments this assembly is as close to the galvanometer as possible. Fasten the 45-degree mirror B to the optical bed by means of the center machine screw, tightening the Allen head set screws 6-40 on both sides of the center screw.

The screws for holding these elements in place should be tightened enough so that the elements retain their position but may be shifted until proper alignment has been secured.

INITIAL ADJUSTMENT OF OPTICAL ELEMENTS - Disconnect the lead from + terminal of B-2 (lower) battery so that the beam will remain stationary during test. Turn on main switch and adjust filament regulator until the voltmeter needle rests on the line. The adjustments described below should be made in subdued light.

Cut a piece of white paper of the same length and width as the 45-degree mirror B and lay the paper against the mirror. Turn the galvanometer bulb up and down

or rotate it until the piece of paper on the 45-degree mirror is completely illuminated. Should it be found that either lower or upper edge of the mirror is not covered by the light, raise or lower the lefthand side of the optical bed plate until the mirror is covered with light through its entire width. Now rotate this mirror so that the reflected light is directed on the galvanometer window. The adjustment of this mirror should be so made that the light falling upon the galvanometer window is bisected by imaginary vertical center line. If this adjustment has produced improper illumination of the mirror B readjust the galvanometer bulb or housing until the mirror is fully illuminated. Check again for the light being central with respect to the long axis of the galvanometer. If this condition cannot be obtained, reposition the mirror again or swing the galvanometer lamp housing slightly one way or another.

Remove the piece of paper from the mirror B and cut and hang a piece of white paper on the first calibration mirror H so that it will intercept all of the light reflected from the galvanometer. The lower edge of this paper should not be allowed to enter the path of direct illumination. Loosen the screws on the galvanometer bearings and tilt the galvanometer to position approximately shown in Figure 27. The lower edge of reflected light must barely graze the metal plate on top of the condensing lens assembly C. If this condition cannot be met by tilting the galvanometer, raise or lower the righthand side edge of the optical bed plate. It will be noted that only lower portion of the calibration mirror H is illuminated.

Until this stage, no mention was made regarding the spots of color within the reflected light field. If the streaks of color are vertical, eliminate them by repositioning slightly the 45° mirror B or by changing the position of the galvanometer lamp housing or the galvanometer lamp. On the other hand, if one or more horizontal streaks of blue color are observed, readjust slightly the righthand side edge of the optical bed plate or raise or lower the galvanometer lamp. After the adjustments are properly made, the reflected light as observed on the paper placed over the first calibration mirror should be of uniform intensity and contain no color. If color cannot be completely eliminated, change the adjustment until the lower portion of the reflected field is white, allowing slight color along its upper edge.

Remove the paper from in front of and place it immediately behind the calibration mirror. The lower edge of reflected light should barely graze the upper surface of the metal plate over the condensing lens assembly C. If necessary, tilt the galvanometer until the reflected light just touches the metal top. In the event that the edge of light is not parallel to this top, loosen the two screws which fasten the galvanometer assembly to the center partition and move this assembly until this condition is eliminated.

Check again for proper illumination of the 45° mirror B and the piece of paper placed on the first calibration mirror H and go over the adjustment again until proper illumination is obtained. Remember that there should be no color in the lower portion of the reflected illumination, whereas a slight color around the upper edge of illuminated field is permissible. Tighten the screws, taking care not to disturb the adjustments.

FINAL ADJUSTMENT OF OPTICAL ELEMENTS - Mount the 45° camera mirror J in such position that it reflects the light just above a circular hole inthe center and top of the center partition. Cut a piece of white paper to cover exactly the area of this mirror with a flap so that it can be hung on the mirror. This mirror should be covered with light throughout its entire width. If the upper edge of the mirror is not lit, the four screws on the first calibration mirror H should be loosened

and the mirror raised a slight amount. If the upper edge cannot be illuminated then lower the camera mirror slightly by loosening four screws holding the mirror in place. Should it be found that the lower edge of the camera mirror is dark, the galvanometer should be tilted a slight amount. In the event that one of the corners of the camera mirror is not illuminated, the screws holding the galvanometer to the center partition should be loosened and the entire galvanometer assembly shifted slightly until the camera mirror is fully flooded with reflected light.

Mount the second calibration mirror M and turn the first calibration mirror H until the second calibration mirror is fully covered with light. In the event that the second calibration mirror is not fully illuminated, loosen the four screws holding this mirror to the mirror mount, and raise or lower it until this condition is met. Now direct the reflected light on the calibration scale by turning the second calibration window M. Move the beam control and note if the scale remains fully illuminated along its long edges. If dark corners are noted adjacent to the long sides of the calibration scale while moving the beam control, the condition should be corrected by raising or lowering one side of the second calibration mirror.

INITIAL ADJUSTMENT OF WIRE PIN - Assemble the mounting piece for wire pin utilizing the threaded hole nearest the pin. Insert the wire in place and secure it in position by tightening the set screw. Now move this assembly toward or away from the galvanometer, observing the beam on the calibration scale. The adjustment should be so made that the beam is sharp and clear-cut.

This pin must be positioned so that it is exactly in the center of the illuminating field. If the pin is not in the center of the field, swing the pin assembly, trying not to disturb its original longitudinal adjustment. To check this adjustment lay a piece of paper on the 45° camera mirror J and turn the beam control until the beam rests against a small metal clamp over the mirror. Note the distance from the other clamp to the dark edge of the beam. Now turn the beam control in the opposite direction until the beam shadow rests against the other clamp and similarly observe the distance from the opposite clamp to the other dark edge of the illuminated field. The above two distances must be the same. If they are not, swing the pin assembly as indicated above. Following this check, make sure that the beam remains sharp on the calibration window. If necessary, move the wire pin assembly toward or away from the galvanometer until this condition is secured.

Tighten the screw holding the pin assembly to the optical bed plate. Next the height adjustment of the wire pin should be made. Still keeping the piece of white paper over the 45° camera mirror J, note if the beam covers the entire width of the mirror. If the beam does not extend all the way down to the lower edge of this mirror, raise the wire pin. If the wire pin is raised too much, the second beam at the bottom of the camera mirror will be observed. To eliminate the second beam, lower the wire pin. Tighten the set screw for holding the wire pin in place.

FINAL ADJUSTMENT OF WIRE PIN - Secure the old cardiopaper roll and draw with ink a line about 10 inches long in the exact center of the paper. Load the camera with this roll and then turn the roll in the unexposed chamber until the slot of the take-up drum rests against the slide and the paper is tight against the slide. Insert the camera in the instrument and run the motor for two or three seconds to make absolutely certain that the paper is tight. Remove the small oval piece immediately above the thumbscrew used for securing the camera to the instrument.

Turn the 45° camera mirror J at the same time observing the cardiopaper visible in the slot in the slide until the reflected light is made to fall upon the paper. The electrocardiograph must be tipped along its long axis so that observation of

the beam on the cardiopaper could conveniently be made through the hole under the oval piece. Loosen the set screw holding the camera lens in place and move it to yield as wide a light on the cardiopaper as possible. Now move the beam control until the beam rests near the center line drawn on the cardiopaper. The beam should be parallel to the center line. If this is not the case, first ascertain in which direction the wire pin E should be bent and then bend it slightly until both lines are parallel to each other.

Now adjust the camera lens K so as to secure narrow streak of light and sharp and clear-cut beam. Note if ruling lines are sharp on both extremities of the light streak. Check the adjustment by taking a sample tracing and note if the ruling and timing lines are sharp at both edges of the paper. Observe if the width of the lines at one edge of the paper remain the same as on the other edge. Also examine the base line. It should be sharp and clear-cut.

Should it be found that the lines are fuzzy on one edge of the tracing, check for the camera lens being parallel to the slide. Insert a scale into the slot of the slide so that it rests on the lens. Measure the distance from each end of the lens to the surface of the slide. If any discrepancy exists, bend the camera lens assembly slightly until the surfaces of the slide and the lens are parallel to each other. Recheck the adjustment by taking another tracing. If the lines are still fuzzy, bend the camera assembly again until proper reproduction of the time lines is secured throughout the entire width of the tracing.

Place the beam on exactly the center line drawn on the cardiopaper, and note if the beam visible on the calibration scale rests on its zero line. If not, bend slightly, the first calibration mirror H until the beams on the cardiopaper and calibration scale are exactly in the center positions. It may be found that the beam on the calibration scale is not parallel to the center line. In such event, determine in which direction the second calibration mirror M should be bent, and then bend it slightly until the beam is parallel with the center line on the scale.

FINAL CHECK AND ADJUSTMENT - Make a final tracing and study carefully for clear-cut base line and proper reproduction of the timing and ruling lines. Repeat some of the above adjustment inclusive of the camera lens until perfect tracing is secured.

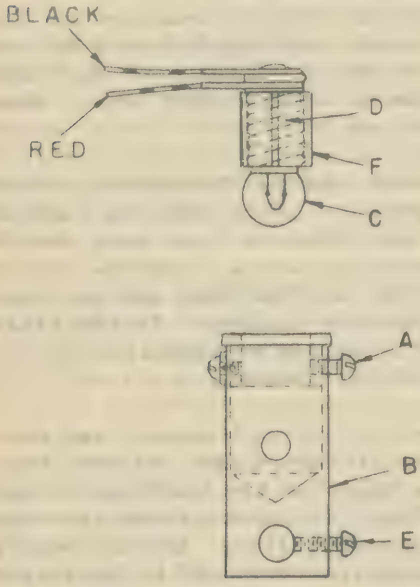
Tighten the screws on all the optical elements, taking care not to disturb any of the adjustments. Wipe the dust that may have settled on lenses and mirrors. If any of these elements have been finger-marked, during the adjustment, remove the marks with a small piece of cotton slightly moistened in alcohol. Blow the dust from the condensing lens assembly C with an air syringe. Make another sample tracing to make certain that everthing is in proper order. Restore the front plate. Reconnect the B-2 battery and check the voltage of the A battery. As the A battery is in the circuit during these adjustments, it may have become sufficiently low to require replacement.

OPTICAL SYSTEM DIFFICULTIES - Although most of the difficulties that may be experienced with the optical system can be eliminated by following the preceding section, they are lumped together and described below under proper headings for the sake of simplicity of reference.

ADJUSTMENT AND REPLACEMENT OF GALVANOMETER LAMP - The galvanometer lamp is a special lamp not interchangeable with standard 2.4-volt lamps available on the market. Occasionally the lamp may slip in the housing, therefore producing improper illumination. After a period of use it may become sufficiently darkened

so that excessively long developing time will be required to obtain a tracing of satisfactory density. The life of this lamp as of any other incandescent lamp is indefinite and occasional replacement is required.

To effect the lamp replacement, loosen the screw A, Figure 28 in the lamp housing B and lift out the lamp socket D. Be careful not to disturb the lamp housing B when removing the lamp and do not loosen the screw E or the screw on the other side of the housing opposite the screw A.



GALVANOMETER LAMP ASSEMBLY
FIG. 28

Before replacing the lamp, slip the split metal bushing F over the socket D. Unscrew the old lamp and screw the new lamp firmly into the socket. Poor contact in the socket will cause an unsteady beam and result in unsatisfactory operation of the instrument. After screwing the lamp firmly into position, wipe it with a soft tissue paper to remove fingerprints.

Slip the socket with the lamp into its housing and tighten the set screw A lightly so that the socket retains its position, and at the same time is loose enough to be moved about for final adjustment. Remove the camera and place a piece of white paper over the 45° camera mirror J, Figure 27.

Move the lamp up and down and rotate it until the light as observed on the piece of white paper is of maximum intensity and evenly distributed. For this adjustment, the beam control should be placed in the central position so that the beam rests in the center of the calibration scale. When properly adjusted there should be no color in the illuminated field, as observed on both the paper over the mirror and on the calibration scale, except near the short edges where the light ends. If color cannot be entirely eliminated, adjust the lamp to obtain white light on the paper, allowing some color on the calibration scale. In the event that the lamp housing B had been accidentally moved, refer to the section "Initial Adjustment of Optical Elements".

INSUFFICIENT ILLUMINATION-LONG DEVELOPING TIME - In most of the cases, improper adjustment of the galvanometer lamp may be responsible. Therefore, try adjusting the lamp as described in the preceding section and check by taking a sample tracing, noting if shorter developing time is required to produce sufficient density. Smoky deposit on the lamp may also be responsible. If this condition is noted, or if in doubt, replace the bulb.

Wipe the lenses and mirrors with a soft cloth to remove dust. Do not forget to clean the galvanometer window, using a small piece of cotton wound round a toothpick and slightly moistened in grain alcohol.

If the 45° camera mirror J, Figure 27 is not flooded with light throughout its width, the light falling upon the cardiopaper may not be sufficient, thus requiring long developing time. Using a piece of white paper, ascertain if the mirror is fully illuminated. If not, loosen slightly the screws on the bearing clamps and rotate the galvanometer. For complete details on this adjustment, consult the section "Final Adjustment of Optical Elements".

Low-reading voltmeter may also account for insufficient illumination. Although this possibility is remote, the voltmeter should be checked if other adjustments fail to correct the condition. Defective mirror inside the galvanometer or dirty deposit on it may also be responsible. Resort to replacement of the galvanometer only if all other adjustments fail to correct the condition.

TRANSPARENT BASE LINE - If the reflected shadow of the wire pin E, Figure 27 is not sufficiently dark, the timing lines will be observed in the base line. Furthermore, the beam on the calibration scale will not be as dark as it should be. The most prevalent cause for this condition is the film of oil or dirt on the galvanometer window. To clean the window, remove the camera and the front plate from the instrument. Wipe the dust with a piece of cotton. Clean out the oil with a piece of cotton wrapped around the end of a toothpick and very slightly moistened in grain alcohol. Several tries may be required in order to remove the deposit.

Similar condition will result if the wire pin E, Figure 27 slips down in its receptacle. Under this condition, it will be noted that the reflected shadow of of the pin on the 45° camera mirror J does not extend all the way down. To rectify the difficulty, raise the wire pin and tighten the set screw. The wire pin should not be raised too much. Otherwise, a second shadow will appear in the lower portion of the camera mirror, causing a white streak along the tracing.

Dust or grease on other optical elements may also contribute in decreasing the opacity of the beam shadow. Excessively long developing time until the tracing is exceedingly dark may also cause the timing and ruling lines to show through the base line.

WHITE DOTS ON CROSS-SECTION OF TIMING AND RULING LINES - White dots formed at the cross-section of the timing and ruling lines will be observed on the tracing if the camera lens K, Figure 27 is out of adjustment. It will be found that this condition is also accompanied by fuzzy rendering of the base line. To correct this condition, consult the section "Final Adjustment of Wire Pin". It may also be pointed out that developing the tracing for too long a time may result in formation of the dots at the cross-section of the measuring lines. The remedy is obviously to develop a tracing to a lighter density.

FUZZY BASE LINE ON TRACING - When complaint on lack of sharpness of the base line is made, examine the portion of the tracing taken on the lead selector position "S". This is essential as, at times, the patient with somatic tremor may produce a base line which may appear to be not sufficiently sharp. While making an examination of the standardization lead, also examine the timing and ruling lines. If both lines are rendered satisfactorily, wire pin E, Figure 27 is not straight or is improperly positioned. To rectify this difficulty move the wire pin assembly toward or away from the galvanometer until the beam as visible on the calibration scale is sharp and clear-cut. Check by taking a tracing, and adjust the pin slightly for final adjustment. On the other hand, if fuzzy base li on the tracing is accompanied by improper rendition of the timing and ruling lines, the camera lens assembly K, Figure 27 may be responsible. Examine the lens for defects or dirt and readjust it as indicated in the section "Final Adjustment of Wire Pin".

On rare occasions, faulty galvanometer mirror can be responsible. Therefore, if other adjustments are of no avail, verify the possibility of fault in the mirror by replacing the galvanometer.

TIMING AND RULING LINES FUZZY ON ONE EDGE OF TRACING - This condition may occur occasionally or be present consistently on all tracings. If only occasional difficulty with improper rendition of the timing on one edge of the tracing is experienced, improper loading procedure can be suspected. It is suggested that the customer be instructed in the method of loading as described in the section "Proper Method of Loading and Handling Camera".

On the other hand, if all tracings show improper rendering of the measuring lines on one edge of the tracing, the camera lens K, Figure 27 may be at fault. Check for defects in this lens, clean it with soft tissue paper if dirty. This lens must be parallel to the slide. If the assembly on which this lens is mounted is bent, the measuring lines will not be in good focus on one edge of the tracing. Insert a graduated scale into the slot in the slide on each end of the lens. If any discrepancy exists, bend the lens assembly until both surfaces are parallel.

Bent lever pressing against the unexposed roll can also be responsible. Make sure that this lever touches the metal spool on both edges. If it bears against the roll with only one edge, the paper may tend to travel in a corkscrew fashion.

Occasionally, this difficulty can be attributed to the paper's climbing on the rim on the slide in the camera. It is suggested that the corner of the rim on the unexposed chamber side be filed off to overcome the difficulty. The alternative is to replace the slide with a new one.

"GHOST" SHADOW ON TRACING - "Ghost" shadow is a white streak below or above the base line visible on the tracing. This streak does not obliterate the measuring lines and is not as sharp and clear-cut as the base line.

Straight line streaks are caused by fairly large dirt or dust particles on any of the elements comprising reflected illumination systems shown in Figure 27. The remedy is obviously cleaning the elements, using soft tissue paper. If the wire pin E, Figure 27 is raised too high a second beam at the lower edge of the 45° camera mirror J will be present. This second beam shadow on being reflected on the cardiopaper will produce straight streaks along the tracing. To overcome the condition, lower the wire pin, but be sure not to lower it too much. If the wire pin is lowered too much, it will be found that the beam shadow on camera mirror J will not extend down to the lower edge of the mirror. A transparent beam will result if the beam shadow does not cover the entire width of this mirror.

The "ghost" shadow that follows the deviation of the base line heart action is caused by a spot of dirt or large particle on one of the optical elements comprising direct illumination system shown in Figure 26. Cleaning these elements will overcome the difficulty. An air syringe should be used for blowing out the dust particles from the lenses of the condensing lens assembly C, Figure 27. If the particles cannot be removed, the assembly must be taken apart for cleaning and reassembly as specified in the section "Removal and Cleaning of Optical Elements".

If dirt particles have settled on the elements used in direct illumination system, dark spots moving up and down the calibration scale will be noted. On the other hand, if such particles are on first calibration mirror H or the second calibration Mirror M, Figure 27, the dark spots on the calibration scale will appear stationary.

NO REFLECTED LIGHT FROM GALVANOMETER - The light originating from the galvanometer bulb strikes the galvanomater window so that it is bisected by the imaginary vertical line passing through the center of the window. If light is not

reflected from the galvanometer mirror, there is a possibility that the screws in the bearing clamps of the galvanometer have become sufficiently loose to cause the galvanometer to rotate the axis of the pivot studs. Even a very slight rotation of the galvanometer will result in decreased or total lack of reflected illumination. To restore the galvanometer to its original position, follow the instructions described in the section "Initial Adjustment of Optical Elements". Never turn the galvanometer about the pivot studs unless the screws on the bearing clamps have been loosened. The pivot studs are soldered to the galvanometer shell and may break loose unless the bearing clamps have been loosened.

Occasionally the mirror vane may come off the galvanometer string to which it is cemented. When this occurs no light will be reflected from the galvanometer. Grounded sensitivity control or the galvanometer may cause the mirror to turn at one side so that reflected light will not reach out of the galvanometer window. To rule out the possibility of loose mirror vane, disconnect the lead from + terminal of B-2 (lower) battery and note if the mirror has returned to its normal position, reflecting the light through the galvanometer window.

On some occasions, the mirror when deflected far to one side may stick and stay in this position. The movement of the beam control may not change its position and consequently the reflected light will not pass through the galvanometer window. Tapping of the galvanometer case with the finger may serve to loosen the mirror. If this difficulty cannot be remedied or if it recurs, it is best to effect the galvanometer replacement.

WHITE CONICAL STREAKS - When tall deflections from the heart action are encountered, it may be difficult to determine the direction of the deflections as observed on the calibration scale. In a number of cases referred for diagnosis of trouble it was found that the beam was so positioned that the peaks of the deflection fell outside the margin of the calibration scale, and that flashing of the dark edge of the beam at the opposite edge of the calibration scale was mistaken for the peak of the deflection. The tracings taken under this condition will show the base line near one edge of the tracing with the QRS deflections falling outside the paper, and white conical streaks immediately below each tall heart deflection.

Considerable caution should be exercised in positioning the beam on the calibration scale when recording tall deflection. If in doubt as to the direction of the deflection, move the beam control one way or the other until true peak of the tall deflection is determined. If difficulty is experienced with this method, it is preferred to lower the amplification and record the lead in which tall deflection occurs at lower setting of the sensitivity control. A new standardization mark should be made preceding this lead so that the user may not misinterpret the tracing.

This condition is more apt to occur if the wire pin E, Figure 27 is not placed in the center of the illuminated field. If it is found that the pin is not in the center, readjust it as described under heading "Initial Adjustment of Wire Pin".

UNEVEN DENSITY ON ONE EDGE OF TRACING - A tracing properly processed in the darkroom may be darker on one side than on the other. This difference in the density of the background is usually caused by improper adjustment of the galvanometer lamp; it may, however, be caused by excessive dust or dirt on other optical elements. Go over the entire optical system and remove the dust, using soft tissue paper. If necessary, remove the fingermarks or grease with a piece

of cotton slightly moistened in alcohol. Then readjust the galvanometer lamp to secure even illumination of a piece of paper placed over the 45° camera mirror J. Remember that if one side of the paper is illuminated with white light and there is some color present toward the other side of the paper over the camera mirror, the condition just described may also be present. Cleaning of the optical system, adjustment of the galvanometer bulb or making other optical adjustments should eliminate color in the illuminated field and different densities of background on the tracing.

CHAPTER III

DIAGNOSTIC EQUIPMENT

SECTION 1-C

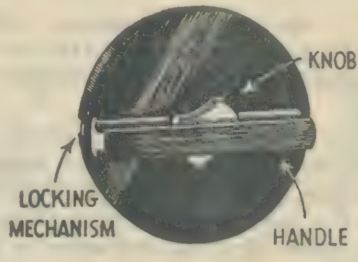
ELECTROCARDIOGRAPHS
- SANBORN -

ELECTROCARDIOGRAPHS

SANBORN CARDIETTE
OPERATING INSTRUCTIONS

STRAIGHT-LINE TEST - To check the operation of the apparatus and to familiarize yourself further with the controls, run a preliminary "straight-line" test without a patient as follows.

To Connect Paper - In the middle of the handle of the record container is a knob with finger holds. Turn knob clockwise as far as possible and without releasing it, pull out cover.



RECORD CONTAINER COVER

Slide camera lever to "Run" and let an inch or two of paper run into container. (The 2-second clock mechanism produces a ticking sound while the camera is running. If it fails to tick, snap lever off and immediately on again.) Turn camera off.

In the container is a bobbin with a slotted disc. Thread paper in slot nearest opening. Turn camera on and allow paper to wind on bobbin two complete turns to prevent paper slipping from slot and jamming in the container.

To Replace Cover - Turn and hold knob until cover is squarely set on container. Then release knob and turn cover by handle until a click signifies that the locking mechanism has engaged. When the cover is properly in place, the handle is horizontal.

To Standardize - The following procedure adjusts the sensitivity of the apparatus so that the record will conform to the international "sensitivity" standard.

Turn main switch to "Std". It will take about a minute for the amplifier to reach operating stability. The glass scale should become illuminated and a dark line will be visible.

If the scale does not light, turn beam knob (also marked 1 MV) until light appears, or turn camera on just for an instant to remove one of the camera timer blades from the path of light.

Turn beam knob to bring dark line to center of scale. This dark line is referred to in these Instructions as the "beam".

Press 1 MV knob briefly (also marked Beam) and notice the distance that the beam deflects or "jumps". To get proper deflection--1 centimeter (1 space on the glass scale), turn sensitivity knob clockwise to increase the jump or counterclockwise to decrease it.

To Take Record - Draw back autographic slot cover and write "Test" with a soft lead pencil.

Set lead length indicator at "0". (Each short white mark on the dial represents six inches of paper; each long mark a foot. The camera runs an inch of paper a second.) Turn camera on. Press 1 MV knob to standardize record. Press lead marker (plunger button at head of glass scale) once for practice. (In straight-line tests this mark has no significance.

NOTICE - To avoid magnetizing your watch, do not wear it near the apparatus.

Let camera run until pointer reaches the first short mark on the dial. Turn camera lever off. Turn main switch off.

Again start camera, letting it run about one-half small space on dial to bring forward all the record that has been taken.

If you wish to develop the straight-line test at this point, turn to paragraphs on "To Cut and Remove Record" and "To Develop Record". As this is not a permanent record, you may reduce fixing time to five minutes and merely rinse the record afterward.

TESTS ON PERSONS - It is suggested that the operator run several tests on normal persons before taking tests on patients. Choose for first tests a person who is calm, quiet, and can relax.

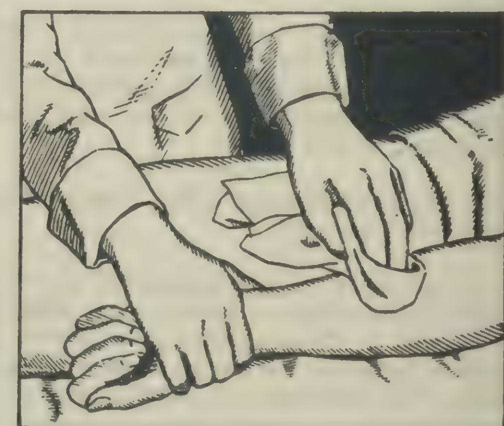
To Prepare Patient - The patient may sit in a chair provided that it is large, comfortable, and has arm rests. (A metal chair should never be used.) It is preferable to have the patient lie down, and a cot wide enough and long enough to support the patient's arms and legs is recommended. An examining table is not satisfactory as it is rarely comfortable, and is frequently wired, thus presenting possibilities of electrical interference. It is important to have the patient relaxed and comfortable throughout the test.

To make the patient feel at ease, assure him that an electrocardiograph test is like "taking a picture".

Turn main switch to "Std" so that the apparatus may "warm up" while you are connecting patient.

Bare forearms and calf of left leg. If chest lead is to be taken, arrange patient's clothing so that an electrode can be applied later to the chest.

Spread a small amount of Redux over a spot on the inside of the forearm. Scrub the area with a towel, piece of gauze, or tongue depressor until there is a slight reddening of the skin.



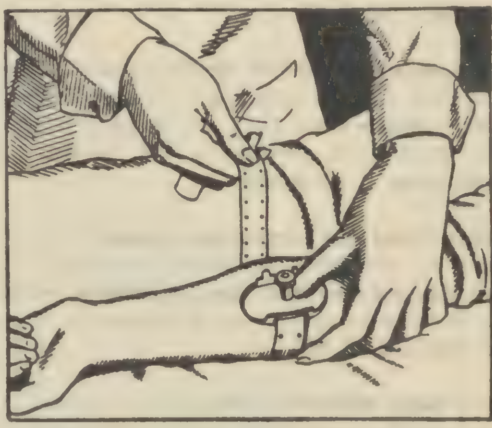
As the paste should make actual contact with the electrodes, add a little more paste to skin or directly to plate surface of electrode.

It is important to apply the Redux carefully in order to keep the patient's resistance low. Low patient resistance reduces the likelihood of electrical interference, somatic tremor (muscle twitching), and beam wandering.

Place electrode on scrubbed area. Draw strap around arm and fit perforations on the two prongs. Draw strap firmly but not too tightly as any discomfort may cause somatic tremor, which will mar the record.

In the same way, place an electrode on the other arm and one on the left leg. As the skin resistance of the leg is usually higher than that of the arms, use a little more friction in rubbing.

Plug patient cable in rectangular socket at upper left corner of panel. Attach patient cable terminals -- insert metal pin at end of white terminal marked "RA" into hole of right arm electrode post and tighten screw. Attach black terminal "LA" to left arm electrode, and red terminal "LL" to left leg electrode, in same way.



IMPORTANT - Even when only one lead is desired, always have all three cable terminals connected to the patient to insure proper functioning of the A-C eliminator. If one lead is left disconnected, interference may occur.

INSTOMATIC BUTTON

After the Cardiette has been standardized and patient has been connected, press and hold down Instomatic Button located to left of Sensitivity Control. While button is depressed, turn Lead Selector Switch to desired lead. Release Instomatic Button. Turn camera on to record lead.

(The Instomatic Button acts to neutralize any disturbance of the amplifier while turning from Std position to any lead, or when turning Lead Selector Switch from one lead to another. By using the bottom, the operator will be able to switch instantly from lead to lead without waiting for beam to "readjust" itself.)

To Make Test - Draw back autographic slot cover and write patient's name. If more room for writing is needed, run camera a moment.

Set lead length indicator at "0". Each small white mark on dial represents six inches of exposed paper.

Check standardization. The beam should deflect exactly 1 centimeter (1 space on glass scale) per millivolt. No further adjustment of the sensitivity knob during the test should ordinarily be necessary.

To Take Lead I

Turn Main switch to "1".

The beam showing the heart beat should pulsate steadily near center of scale. If it swings erratically across the scale, see that the patient is comfortable and not moving his limbs, and that the electrode connections are firm. The patient should not talk during the test.

Turn camera on.

Push down 1 MV knob briefly.

Press lead marker button once briefly -- to mark Lead 1.

When paper indicator has traveled the required distance, six or twelve inches, turn camera off.

To Take Lead II

Turn main switch to 2.

Turn camera on.

Push down 1 MV knob.

Press lead marker button once.

Let camera run the same distance as Lead 1 (watch indicator). Turn camera off.

To Take Lead III

Turn main switch to 3.

Turn camera on.

Push down 1 MV knob.

Press marker button three times, and let camera run as in previous leads. Turn camera off.

If the chest or precordial lead is not required, turn main switch off.

*To Take Lead IVF**

To an area on front of chest at outer border of apex, apply a small amount of Redux and rub well into skin.

Place chest electrode over this area. Have patient or assistant hold electrode by its handle.

Disconnect RA terminal and attach it to chest electrode. *Leave the other connections in place.*

Turn main switch from 3 to 4, and proceed as for the other leads, Marking this "4". Turn main switch off.

Other Chest Leads

Lead IVR* -- Turn main switch to Std. Attach LA terminal to chest electrode. Turn main switch to 3. Proceed as for other leads.

Lead IVL* -- Turn main switch to Std. Attach LL terminal to chest electrode. Turn main switch to 3. Proceed as for other leads.

*According to terminology of the American Heart Association (1938). The procedure outlined produces IVF, IVR, and IVL even though the steps differ from those used on other electrocardiographs. The design of the instomatic main switch makes

the necessary transposition of the wires if the above directions are properly followed. Chest leads are optional.

To Complete Test - Start camera again, letting it run two or three seconds, about one-half small space on dial, to bring forward all the record that has been taken

Disconnect patient. Remove electrodes. With a damp cloth wipe off Redux from patient. Wash electrodes thoroughly in hot running water. Dry electrodes and cut paper or cardboard ovals to cover surface of electrode contacting patient's skin. This will prevent rubber straps, which are wound around the electrode from tarnishing the surface of the electrode.

During this test if the patient has been completely relaxed, you will have noted that the beam position was hardly disturbed when you switched from one lead to another. If, therefore, speed in taking a test is of importance, it will, in most cases, be possible to turn the camera on and leave it running as the main switch is turned through the first three leads.

To Cut And Remove Record - Grip handle of record container and turn counterclockwise as far as it will go. This cuts off exposed record and seals container against light.

Pull container out of housing and take to dark room. In dark room turn on safety light. Take off cover of record container. Pull out roll.

Put container aside so that it will not fall and be damaged.

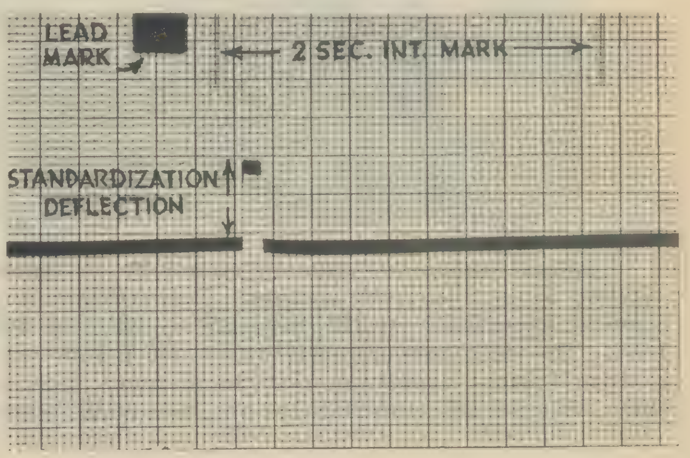
To Develop Record - Immerse record in developing solution and move it about frequently so that the solution will act evenly. Examine record from time to time and remove from developer when good contrast is obtained -- three to five minutes.

Rinse record thoroughly in clean water to remove as much developer as possible.

Immerse it in fixing solution at least 15 minutes.

Wash in running water or water that is changed frequently for 15 minutes.

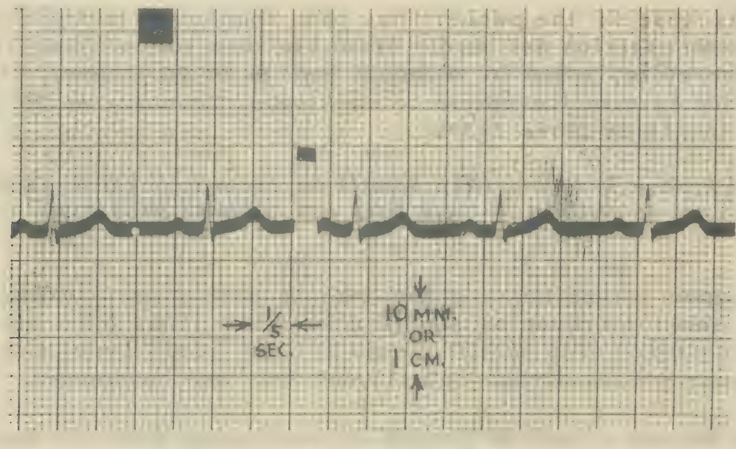
Record may be dried by hanging up, putting it on clean blotting paper, or rolling it out on ferrotype board.



To Compare Record - The fine vertical lines on the record are 1/25 second apart; the heavy lines, 1/5 seoonds apart. The fine and heavy horizontal lines occur at 1 millimeter and 1/2 centimeter distances, respectively. If the Cardiette is properly standardized, each millimeter represents 1/10 of a millivolt.

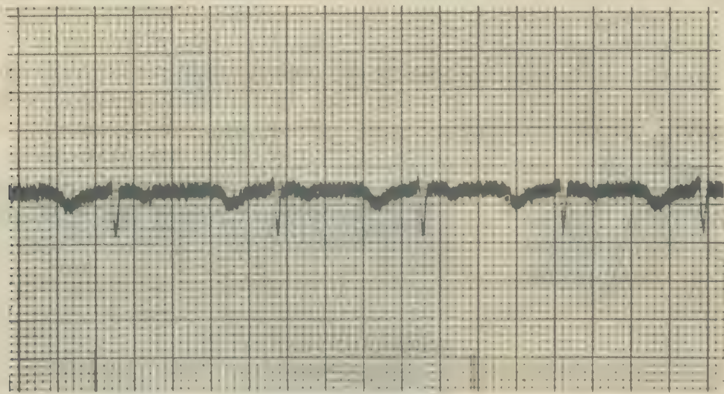
To determine the heart rate, multiply the number of complete heart cycles between any two 2-second interval marks by thirty. For example, in the patient record shown on the next page there are a little over 2½ heart cycles between two interval marks; multiplying this figure by thirty gives a heart rate of 75.

If the record is sufficiently long, add a zero to the number of complete heart cycles in any three 2-second intervals (six seconds).



PATIENT TEST

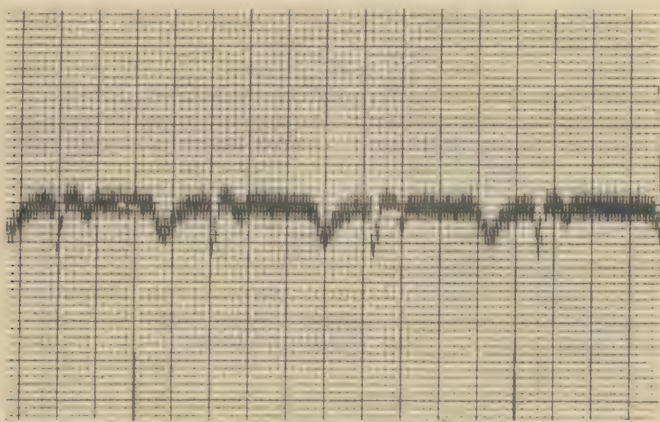
The samples below show two common types of irregular-edged beam shadow. The first was caused by *somatic tremor*. The beam shadow is notched unevenly.



Somatic tremor is usually caused by tenseness or uncomfortable position of the patient or by overtight straps. Its presence may be detected during a test by the changed appearance of the beam after the main switch has been turned from Std to a lead. The beam appears hazy or out of focus. A similar effect is sometimes caused by insufficient scrubbing with Redux paste, poor contact of electrode with patient's skin, or a loose connection at the electrode binding post.

The beam also appears out of focus when somatic tremor is combined with alternating current interference or when A-C interference is present separately.

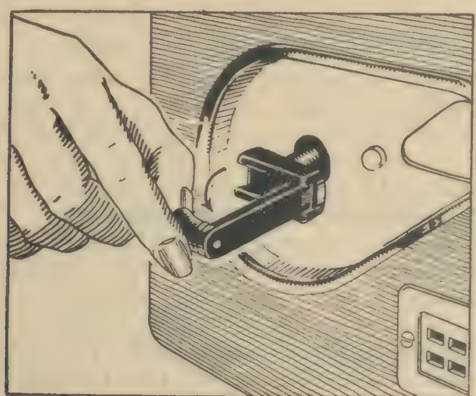
A-C or electrical interference produced by 60 cycle alternating current is illustrated. The base line is notched regularly -- 12 notches for every 1/5 second. Twenty-five cycle alternating current produces 5 notches for every 1/5 second.

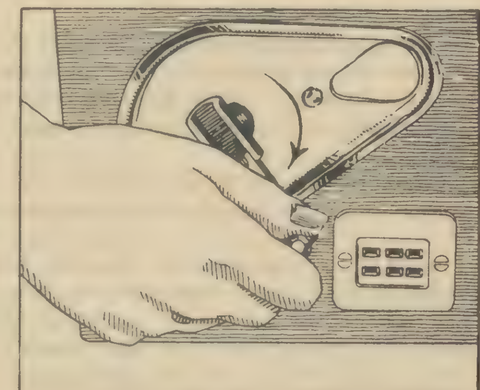


Alternating current interference is further discussed in paragraph, "To Choose a Location". It should not appear on your records, except in rare instances, if the simple precautions given here are followed. If it does, send specimen records to Medical Supply Services School with complete description of operating conditions.

To Replace Record Container - Replace cover. Holding container by handle, align the two posts on container with the slot in roof of housing. Push container in and turn clockwise as far as it will go.

To Rewind Camera - The camera motor may be wound at any time, or when the rewind indicator (the small red pointer on the dial) approaches "Wind" -- between 16 and 20 on the dial. The camera cannot be started again until the spring is rewound.





At back of Cardiette is a crank assembly. Lift out knob and swing it to opposite side. Turn knob clockwise until rewind indicator registers "Full".

Sometimes while the camera is running, the red indicator will go past the "rewind" point, and will continue on for part of a second revolution. Then when the

camera is wound back to the "full" point, it is actually only being partially rewound so that it will stop after a few feet of the record have been taken. To rewind completely, from "rewind" to "full" point, usually requires about 100 turns of the crank.

DARK ROOM AND FINISHING

Location and Lights - The dark room may be the regular X-ray developing room, a small room that can be darkened, or a closet.

A permanent dark room should have good ventilation, electrical connection for a safe light, and running water. There should be some shelves for supplies, and copper wires or string on which the records (if they are not ferrotyped) may be hung up to dry.

Developing Solutions - For electrocardiograph records on standard bromide paper, X-ray developer and fixer are preferable to all other types.

Best results are obtained if the solution is kept between 70° to 75° F. Cold solutions are unsatisfactory for this type of work.

Fresh developer is light brown and transparent. When it becomes opaque and muddy, and the tracings develop excessively slowly, it should be discarded. Fresh fixer is colorless; when it loses its sharp, sulphurous odor and becomes cloudy, it should be discarded.

Ferrotyping - After a record has been removed from the final wash, it may be ferrotyped. Ferrotyping gives the record a smooth glossy finish and prevents it from curling.

The following necessary equipment may be obtained from any photographic supply store.

Ferroplate 14 x 20 inch. (Ferroplates are available in chrome or black enamel at about the same price. We recommend the chrome plate as it does not require waxing.)
4-inch rubber roller
Can of squeegee paste (or Simoniz)*
Piece of cheesecloth -- for applying paste*
Piece of flannel cloth for polishing plate*
Large sheet of white blotting paper.

Wash ferroplate with hot water and soap. (If a black enamel plate is used, apply a thin coat of paste with cheesecloth. Polish to a high gloss.)

Cut record in convenient lengths for the ferroplate. Shake off excess water and lay the strips face downward on the plate.

Cover with sheet of blotting paper. Run roller back and forth firmly several times until all the water is pressed out and the sections of the record adhere flatly to the plate.

Place ferroplate in a warm airy room (near a fan if possible) but avoid too much heat. In 20 or 30 minutes the record should drop off automatically.

*Needed only for use with black enamel plate.

In cold weather records may crack. To make them soft and pliable, soak them a few minutes after the final rinsing in a solution of 15% glycerin and 85% water. (A prepared solution called Flexogloss is also obtainable at photographic supply stores.) The records may then be hung up to dry or ferrotyped as usual.

Mounting - Samples of Sanborn mounting cards are sent with the apparatus. The single cards are for three and four leads and may be kept, with correspondence, in the folder which likewise has space for an electrocardiogram.

MAINTENANCE

BATTERIES - Three batteries are required for the operation of the Instomatic Cardiette: one "A" battery of 1½ volts which lights the filaments of the vacuum tubes and the lamp bulb for photography; one "B" battery of 45 volts which supplies the plate voltage to the vacuum tubes; and one small flashlight cell which supplies the 1 MV for correct setting of the standardization.

The life of the batteries depends, to a great extent, on the amount of use. The "A" battery should provide approximately 18 hours actual operating use; the "B" battery 300 hours; the 1 MV battery from six months to a year. The shelf life, or life without use, of "A" batteries (including the 1 MV battery) is about one year.

Thus, it may be expected that in average use the "A" battery will provide power for 180 patient tests, and the "B" for nearly 3,000 tests.

To Test Batteries - Test batteries at least once a month. If the apparatus is not used over long periods of time, check batteries before each test. (The simplest - and surest - method is to make the following procedure standard during every test):

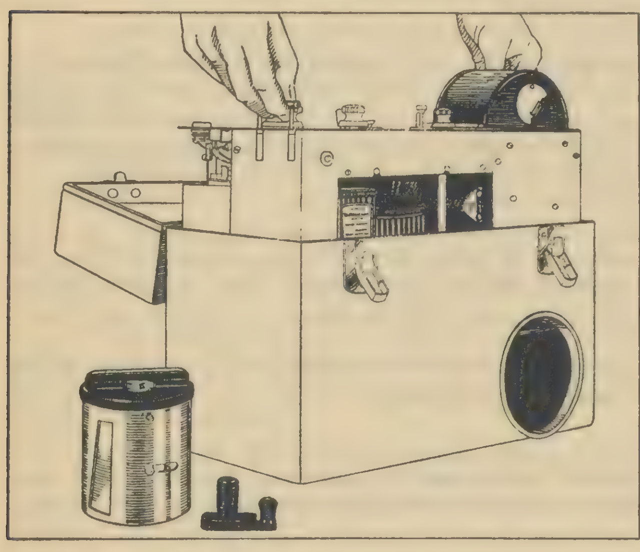
> *1 MV "Standardization" Battery* - Turn main switch to Std. Press 1 MV knob. Meter should register inside the broad 1 MV line. If it registers below, the 1 MV battery should be replaced.
>
> *"A" Battery* - Turn main switch to "A". Meter should register to right of red line; if it does not, replace "A" battery.
>
> *NOTE* - As the "A" battery has the heaviest current drain, it will not -- even when new -- register at full voltage on the meter after the Cardiette has been running a few moments. This does not mean that the cell is about to deteriorate for the apparatus has been designed to operate satisfactorily until the "A" voltage swings to left of the red line.
>
> *"B" Battery* - Turn main switch to "B". Meter should register to right of red line; if it does not, replace "B" battery.

TO REPLACE BATTERIES - *Batteries Required* - The "A" battery required is the Burgess Little-Six 4FH (1½ volts); the "B" battery, Burgess Portable Z30 NX (45 volts); the 1 MV battery is an ordinary flashlight cell size C, and any make is suitable.

The "A" and B" batteries may be obtained from most large radio supply stores, from the Burgess Battery Company in Freeport, Illinois, or their agents, or direct from Sanborn Company. The 1 MV battery may be obtained at any drug store or hardware store as well as the above supply houses.

To Remove Cardiette Chassis From Case - This is necessary to reach the battery compartment. Removing the chassis from the case does not expose the paper.

Remove record container; then turn winding handle counter-clockwise to unscrew. To keep case from tipping over as the chassis is removed, turn apparatus around so that cover rests against your body or have an assistant hold the case. Lift chasis out by the lifting devices on either side of the panel. (Never use control panel for this purpose.) Close case and set to one side.



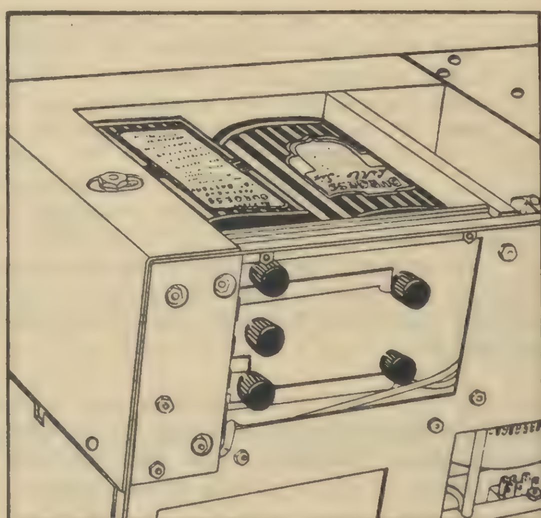
To Put In New Batteries - At front of apparatus, to left of record container housing, is the battery compartment, covered by a metal door. Slide door to left and remove.

Five thumbnuts at bottom of case under battery compartment hold the two large batteries in place. Unscrew the thumbnuts and lift batteries out. *BE SURE TO SAVE THESE THUMBNUTS AS THEY ARE SPECIALLY DESIGNED FOR USE WITH THE BATTERIES;* they have special metal inserts to make contact, and the ordinary thumbnut is entirely unsuitable. Three spare thumbnuts are provided in an envelope in the cover for accessories.

Because of the spacing of the terminals, the "A" and "B" batteries may be replaced only in the correct polarity. They are marked for polarity, and the plus terminal of the "B" and the minus terminal of the "A" enter the compartment first.

Loose contacts may produce an irregular or "jumpy" beam. *TIGHTEN ALL THUMBNUTS AS FIRMLY AS POSSIBLE.*

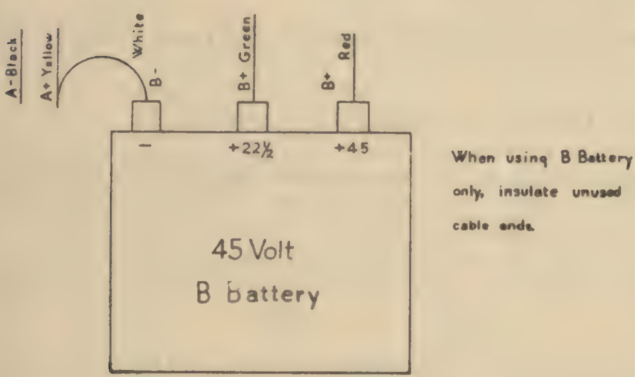
The 1 MV battery is in the small compartment to the right; it is held in place by a clip. Lift old battery out and press the new battery into place in the holder. The positive or center terminal faces the back; if battery is inserted incorrectly, the needle on the voltmeter will read backward when the 1 MV knob is depressed for standardization.

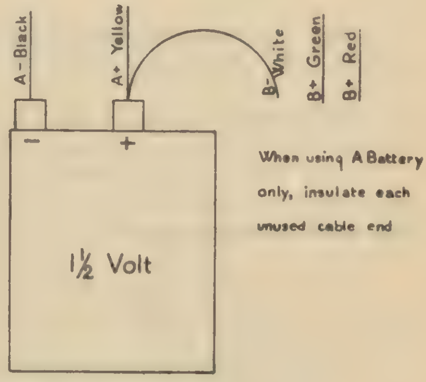


EXTERNAL BATTERIES

For emergency use, or to prolong the life of the batteries in the apparatus, large external batteries may be used in their place. A cable for making connection to the batteries is provided, and this is plugged into the socket below the governor adjustment plate.

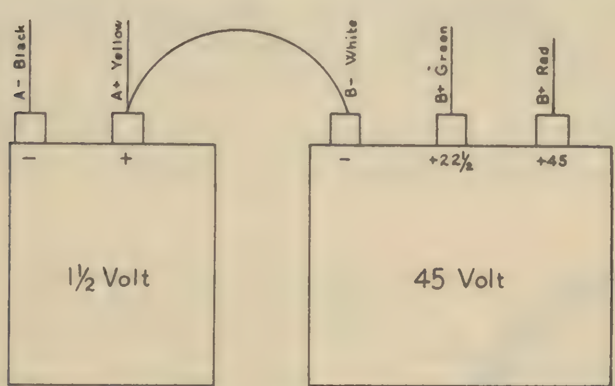
Large batteries may be used in one of three ways, as illustrated:





(1) External "B" battery in cases of emergency one 45 volt battery with a 22½ volt tap.

(2) External "A" battery for emergency use, any 1½ volt "A" battery for long life. Eveready #740 1½ volt with plug connector, has sufficient power to operate from 1000 to 1500 tests without replacement.



(3) External "A" and "B" batteries.

In hospitals where a large volume of work is done, routine use of external batteries is desirable. We recommend a shielded external battery box designed to carry a large "A" battery whose operating life will be approximately equivalent to the standard "B" battery already contained in the Cardiette. A shielded connector cable equipped with a plug at each end connects the Cardiette to the external battery box.

External batteries are obtainable from a radio store, a hardware store, or department store.

LAMP

Lift out black knob with white disc. As the lamp bracket is held securely in place, it may be necessary, in lifting the bracket, to apply some pressure of the fingers under the white disc. DO NOT REMOVE SCREW IN KNOB.

Two lamp bulbs are attached to under side of this unit. The lower bulb is the one in use; the upper bulb is the spare lamp.

To remove either bulb, twist it slightly and pull out of socket.

The black guide mark on the bulb should be at the center top of the socket in line with a similar mark on the socket. This position insures uniform illumination and even photography.

Replace the unit in the Cardiette with the lamp bulbs toward the front. Press unit well down in Cardiette to insure good contact.

These lamp bulbs are especially made for the Cardiette. The voltage and current rating are not standard, and the bulb has a special silver tip to insure good contact. Replacement bulbs should be ordered through the Medical Supply Officer.

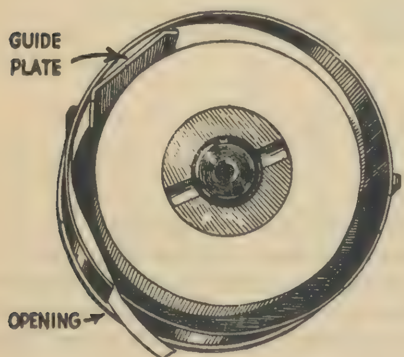
PHOTOGRAPHIC PAPER

To Check Supply In Magazine - On front of magazine is a circular disc that covers a transparent red safety window. Turn this disc to one side and see how much paper is left on the supply roll.

In addition, ten feet from the end of the roll several perforations appear along the edge of the paper.

Photographic paper for the Cardiette may be obtained through the Medical Supply Officer. It comes in rolls of 100 feet, 6 cm. wide.

To Replace Roll Of Paper In Magazine - Lift magazine out of chassis. If any paper is left in the Cardiette between plate and roller, release it by drawing plate away from roller.



If this is the first time you are replacing the paper and there is a small amount left in the magazine, open magazine in daylight and notice how the old roll is threaded.

Take magazine to dark room. Unscrew and remove thumbscrew on side of magazine opposite viewing window. Lift cover off. Set open magazine down. Remove old roll and unwrap new.

Unwind to the left about six inches of the new roll, glossy side toward you. Slide *one edge* of paper behind guide plate in magazine and pass end through opening. Drop roll on spindle.

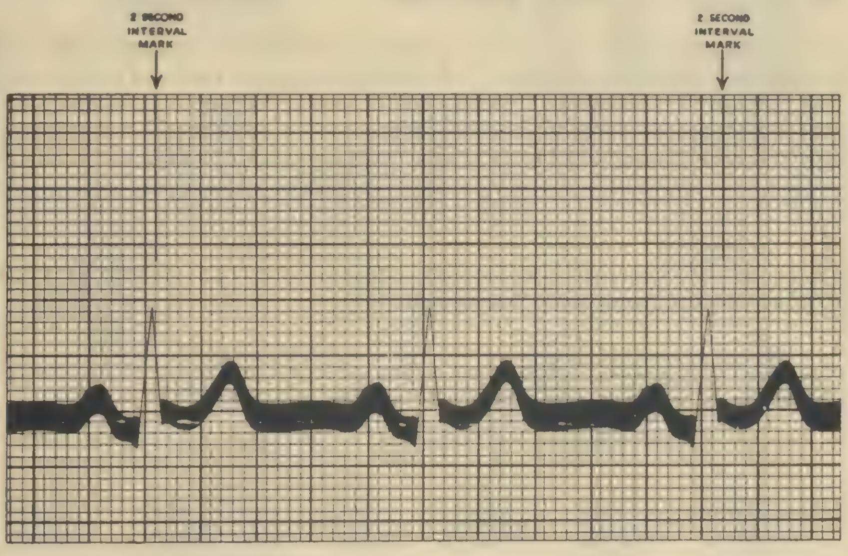
To Replace Magazine - Remove record container cover. Holding magazine, viewing window front, to one side of opening, direct the short strip of paper (issuing from the magazine) between plate and roller. Turn camera on and as the paper folds through, gradually lower the magazine in place. *MAKE SURE THAT ALL THE PAPER IS TAKEN UP AS THE MAGAZINE IS PUT BACK*, for excess paper folded under the magazine may stop the camera.

CAMERA SPEED

The two-second interval marks on the record are a constant check of camera speed.

Two seconds' time is represented on the record by fifty fine vertical lines (or ten heavy lines). A decreased or increased number of lines between two successive marks would indicate some error in camera speed.

For example, the illustration shows a camera that is running 2% fast. The two-second marks occur at intervals of fifty-one fine lines.



An error up to 5% in camera speed is permissible for routine electrocardiographic work.

If Two-Second Mark Does Not Appear.- This marker was incorporated in the new *CARDIETTE*, not because it was considered essential to the proper operation of the instrument, but simply as an independent check of the camera speed. Since it is operated by a balance wheel, hair spring, and escapement mechanism similar to that found in ordinary clocks, it is possible for the balance wheel to be caught sometimes in a so-called "dead center" position. Under these conditions, the clockwork will not start and the two-second marks will not appear on the record. If, however, the camera lever is snapped off and on again, the clock mechanism will be pushed past that center and will operate normally.

TO ADJUST CAMERA SPEED - *To Expose Stroboscope And Governor Adjustment* - This may be done with the Cardiette in the case. Beside the winding handle is a small knurled knob. Turn counter-clockwise to open shutter. The stroboscope is the round disc with twenty-four black spokes.

To Check Camera Speed - Two methods are given (1) for localities where the city power supply is 60-cycle alternating current and (2) for localities where D-C only is available.

(1) Remove paper magazine. Illuminate stroboscope with an ordinary desk lamp running on 60-cycle alternating current. Start camera.

The stroboscope is so designed that the flickering of a 60-cycle alternating current lamp synchronizes with the spokes on the stroboscope if the timing is correct. The black spokes on the revolving disc then appear to stand still while the camera is running. The effect is of course an optical illusion, and it is much more pronounced if a Neon lamp or a modern fluorescent light is used as a light source.

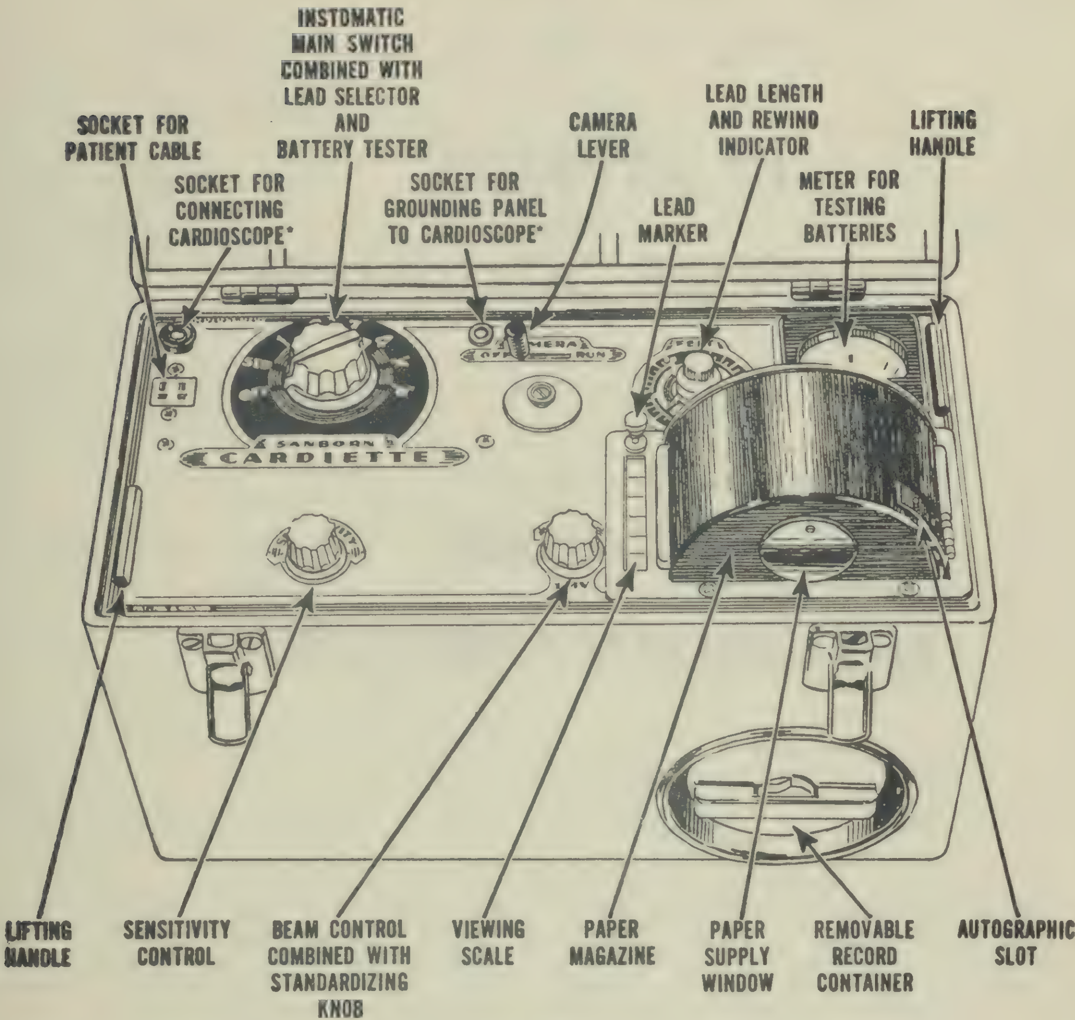
If camera speed is too fast, the black spokes will appear to move in the direction of rotation, or counter-clockwise; if too slow, they will appear to move clockwise. A slight travel in either direction does not warrant further adjustment as the testing device is extremely sensitive.

(2) For D-C localities, run a short straight-line test and count the lines between two two-second interval marks. For exact speed there should be fifty fine lines.

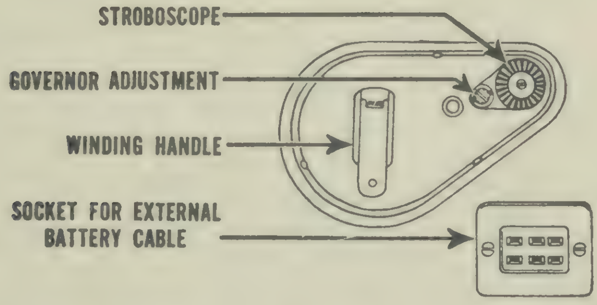
To Change Camera Speed - With a screw driver turn screw in center of stroboscope clockwise until another screw -- the governor adjusting screw -- appears in the small round opening at left of stroboscope.

To increase speed turn the governor adjusting screw slightly clockwise. To decrease, turn slightly counter-clockwise.

OPERATING PARTS



(IN BACK)



*The Cardioscope is a Sanborn apparatus which makes possible the viewing of the cardiogram in the form of a fluorescent image. The socket is not required in the operation of the Cardiettc itself.

CHAPTER III

DIAGNOSTIC EQUIPMENT

SECTION 2

SPHYGMOMANOMETERS

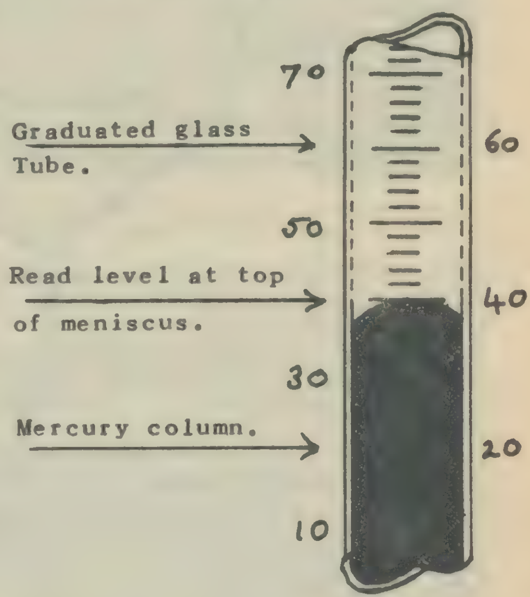
1. The purpose of a Sphygmomanometer, or blood pressure apparatus is as its name implies, a device for ascertaining blood pressure.

2. Two readings (expressed in millimeters) are taken on a Blood Pressure instrument. The Systolic, highest pressure; Diastolic, lowest pressure. A patient's blood pressure is thus expressed as the systolic pressure over the diastolic pressure.

3. Two types, "Mercury" and "Aneroid".

4. MERCURY TYPE - The Mercury oxidizes and has to be cleaned occasionally; under average conditions about once a year - (frequency depends upon climatic conditions, (i.e. temperature and humidity).

5. TO SERVICE INSTRUMENT AND CLEAN MERCURY - Lay unit on side so mercury spills into reservoir. Remove knurled knob at top of glass tube, push up catch and remove tube, taking care that cork gaskets are not mislaid. Remove reservoir by taking out holding screw (unscrew reservoir from its base) empty mercury into glass beaker or similar container. Clean out reservoir and tube, clean white background of tube. Construct a paper funnel with very small outlet about 1/32" to 1/6" in diameter. Pour mercury from container through funnel and into a second container. If hole in funnel is of proper diameter the funnel will pass clean mercury, the oxidized mercury being retained on the sides of the funnel; repeat this process until mercury is clean.



Reassemble instrument except top plug of tube and pour back mercury through the top of the glass tube. There should be sufficient mercury to reach zero in tube, if necessary add more. The instrument has a capacity of approximately 1/4# mercury. The mercury in the tube will have a meniscus, i.e., the level of the mercury will be convex, read from top of the convexity. If extra cork gaskets are available use new ones when reassembling, i.e., one at each end of tube; one at base of reservoir.

6. AIR FLOW VALVE - This is incorporated in the Bulb. If the pressure cannot be maintained on the column of mercury, check this valve, make sure it seats properly. Note there is a removable rubber disc attached to the coil spring. This may be replaced if necessary. The seat itself may be cleaned with the orange stick furnished with each instrument.

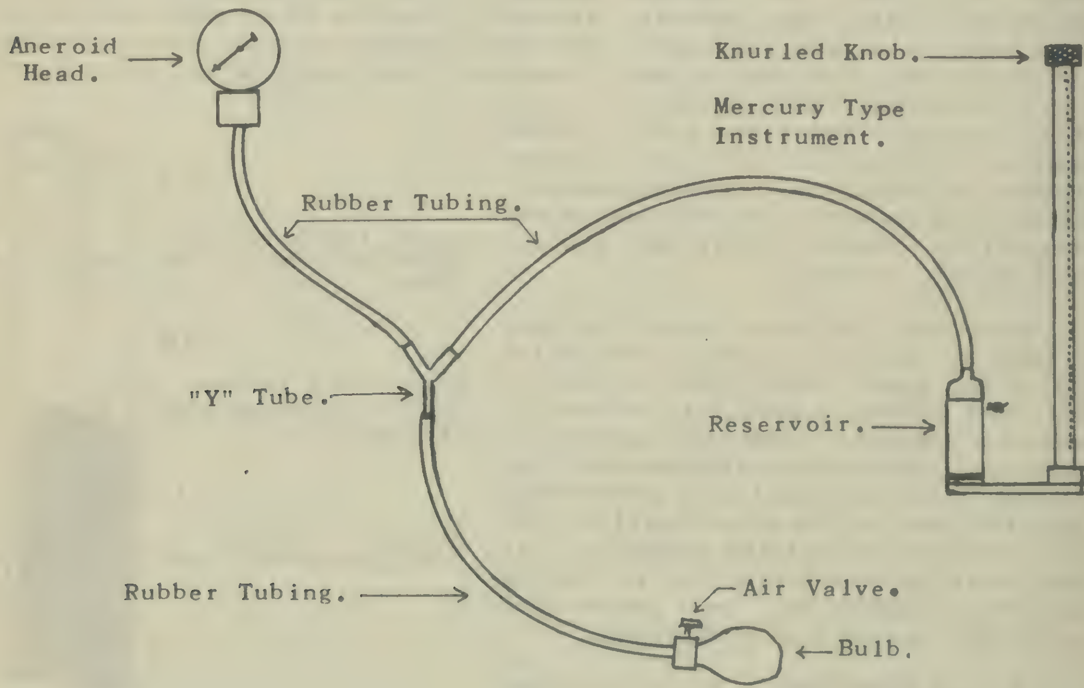
Deterioration of the rubber parts, bulb, bag, tubing, etc. can also cause leaks, in which case the part will have to be replaced.

7. ANEROID TYPE - Under certain climatic and altitude conditions the Aneroid type instrument may have to be recalibrated.

On an Aneroid type the pointer when at rest should be in position over the zero mark. It does not have to center as long as it covers the mark in one position or another. If the hair spring controlling the pointer is not broken the pointer may be

reset, by lifting it off the pivot and replacing in proper position. If the hair spring is broken the pointer will swing in which ever direction the head is tilted - in other words the spring will have no control over the pointer; in which case a new spring will have to be installed.

8. HOW TO CHECK ANEROID TYPE FOR ACCURACY AND RECALIBRATION - Obtain a glass Y tube (from the laboratory) and attach about 12" rubber tubing to each leg of the Y and to the stem of the Y. To one of the rubber tubes attached to a leg of the Y, attach the head of the Aneroid instrument. Fasten the other tube to the reservoir of a mercury type instrument. To the tubing from the stem of the Y attach the rubber bulb. Blow up the bulb until the mercury column reaches say 200 mm, then check the Aneroid head to see if it also reads 200 mm, which it will do if the Aneroid is accurate. Then repeat this process from the top down the whole scale of the mercury instrument checking the Aneroid every 10-15 mm. It is necessary to do this as the Aneroid may coincide with the mercury instrument at certain points but not all through the scale.



BAUMANOMETER
HOW TO MAKE IT READY FOR USE

CAUTION: Never attempt to remove the glass tube unless the instrument is resting on its *right* side, and leave it in that position until the tube is replaced or the mercury will be spilled!

For convenience, the mercury is shipped in the steel reservoir, which is temporarily closed at both ends to prevent air circulation. To make the instrument ready for use, lay it on its *right side* (see the pictures), spread this sheet before you and proceed as follows:

Hold left hand against lower side of scale, place the right thumb on UPPER edge of projecting flange and the fingers on end of instrument. (See picture above.)

Now move the flange out to the right, by pressing the thumb and fingers of right hand toward each other, and the Cartridge Tube will drop into your left hand. Allow the projecting flange to return to its normal position, by releasing the pressure of the thumb on it, then pull out AND DISCARD the SOLID (white-tabbed) washer ONLY from the bottom socket. *Do not injure or remove the cork-facing of the socket, which is underneath the solid washer.*

Hold the tube in the left hand, at an angle of about 15° to the scale, and with the etched lines facing toward you, insert the WHITE-tipped end into the upper socket. *It is important to insert the upper, white-tipped end FIRST.*

(Study this picture before proceeding)

NOW (a) Move the projecting flange out again, with thumb and fingers of the right hand, *(Keep the white-tipped end of tube in upper socket while doing this.)*

(b) then swing tube in toward scale until the RED tip is opposite the lower socket,

(c) see that the WHITE DOT is in line with the SLOT in the lower socket,

(d) then *slowly* release the pressure on the flange, while the left hand guides the RED-tipped end of the tube safely into the lower socket.

First be sure that both ends of the tube are securely inserted in the sockets, *then press firmly on the top socket in a direction lengthwise of the tube. This will "seat" the ends of the tube against the cork-faced bearing surfaces of the sockets.* Next turn the instrument to an upright position. The mercury will now flow into the tube from the reservoir. Finally, remove and discard the Rubber Cap on the end of the nozzle above the reservoir, slip the end of the rubber tube well down over the nozzle, and the instrument is ready for use.

IMPORTANT - This instrument is shipped with exactly the right amount of mercury in the reservoir. If any of it should accidentally be spilled while carry-out the previous Instructions, place the instrument in an upright position on a level surface, unscrew the knurled cap at the top of the tube, then add enough mercury to bring the rim of the meniscus (the convexity produced at the top of the mercury column by surface tension) even with the zero line on the Cartridge Tube. The eye should be on a level with the zero line when judging this. Then replace the knurled cap, screwing it on firmly with the thumb and finger.

There is sufficient space in the portable models to comfortably accommodate the complete inflation system when properly placed,--the tube leading from the reservoir (which should remain permanently attached thereto) laid along the side and front of the case in a "U" shape, the bulb in the forward right-hand corner, with its metal part held in the clip provided for that purpose and the cuff folded, as explained on the wrapper around it, and placed alongside the bulb.

BECTON DICKINSON MEDICAL CENTER MANOMETER

DIRECTIONS FOR PREPARING INSTRUMENT FOR USE - The required amount of mercury is retained within the Bakelite reservoir by means of a Bakelite plug in the tube socket.

Two manometer tubes are supplied with each instrument. The one to which the slotted metal cap is attached is ready for use.

Open the case and place the instrument on its left side, allowing it to remain there until the following directions have been carried out, otherwise the mercury may be spilled.

Turn the knurled metal nut downward (toward the reservoir) until the Bakelite plug may be removed and discarded. Keeping the instrument on its side, hold manometer tube, with slotted cap to left, parallel to white tube support. Slip cap through ring at top of scale and then back until it is engaged by knurled nut.

Exert a slight pressure on the tube toward the base and tighten the knurled nut by turning it upward (away from the reservoir) until the tube is tightly seated. Then place instrument in upright position on a level surface.

Before using, be sure that the rim of the meniscus (the meniscus is the convexity at the top of the mercury) is level with the zero line, etched on the manometer tube. If for any reason the mercury is below this point, add sufficient to restore this level. To add mercury, unscrew the cap on top of the manometer tube. A small medicine dropper or pipette may be used when small amounts of mercury are to be transferred. Replace cap, after being certain that the disc of metal gauze, the special leather disc and the cork washer remain within.

In the event that the discs within the cap become separated from it they should be replaced as follows:

First, and uppermost, the disc of metal gauze,
Second, the disc of specially prepared leather,
Third, the cork washer which hold the discs in place

Under no circumstances use ordinary leather, rubber, etc. instead of the above. New discs will be supplied, gratis, on request. Attach inflation system tightly to reservoir. The instrument is now ready for use.

CLEANING - Owing to the fact that Bakelite does not amalgamate with mercury and that metal is not permitted to come in contact with the mercury, there should be little necessity for cleaning. Should cleaning be required, it may be accomplished as follows:

Remove slotted cap by means of a coin. Then place instrument on its left side and swab tube with cleaner supplied with each instrument. Then raise instrument to upright position and replace cap.

The reservoir is provided with a cap so this also may be cleaned. Use no liquid but, preferably, a soft dry cloth for this purpose.

INTERCHANGEABLE MANOMETER TUBE - The tube of the B-D Manometer, Bakelite model, is thoroughly cushioned to safeguard it against breakage. Accidents may occur, however, and for that reason we supply an additional manometer tube with each instrument. This permits the physician to interchange tubes without the usual loss of use and the time required to obtain a new tube. However, only one metal cap (non-spilling device) is supplied. This should be attached to the tube in use.

In the event of breakage, place the instrument on its left side and keep it there until the broken parts of the tube have been removed and the new tube inserted in its place.

To remove the tube, turn the knurled metal nut downward (toward the reservoir) until the manometer tube may be removed. To insert new manometer tube, see "Directions for Preparing Instrument for Use".

THE AUSCULTATORY METHOD - Apply sleeve to bare arm just above the elbow so that part of the sleeve which contains the rubber compression bag will be directly over the brachial artery. Wrap the sleeve around the arm snugly, but not tightly and tuck the end of the sleeve under a preceding fold.

Connect inflation system to instrument by means of slip joint connection. Then place the bell of the stethoscope over the radial artery just below the bend of the elbow or over the bifurcation in the bend of the elbow.

Then force air into the sleeve by slowly compressing the bulb until thumping sounds are heard through the stethoscope.

Continue compression until these sounds completely disappear.

Then allow the mercury column to fall a few millimeters at a time by opening and closing the release valve until a faint thumping sound is heard through the stethoscope. This is the Systolic pressure.

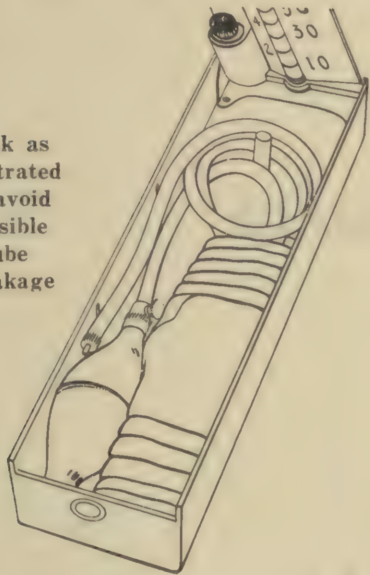
Continue to allow air to escape through release valve and note change in sounds as the artery expands. Several phases occur but these need not be considered because of their variability.

As more air is allowed to escape the sounds gradually become sharp and snappy, then suddenly change to duller sounds, then disappear entirely.

The point where the sounds change from sharp and snappy to dull just before the complete disappearance of all sounds is the Diastolic pressure. There is usually a difference of from 3 to 8 mm. between the Diastolic pressure and the point where the sounds have completely disappeared.

In short, after complete obliteration, when the first sound is heard you have the Systolic pressure; when the thumping sounds change from sharp to dull, you have the Diastolic pressure.

Pack as illustrated to avoid possible tube breakage



IMPORTANT

Before closing case, detach rubber tubing from reservoir and remove all air from the rubber bag. Fold loosely and place in bottom of case as illustrated.

Space is provided in left forward part of case for the bulb.

As authorities differ as to which point really represents the Diastolic pressure it is well to record the Diastolic determined as above as the fourth phase Diastolic, and the complete disappearance of sounds as the fifth phase Diastolic.

The above method is recommended and the one used and approved by medical directors of Life Insurance Companies and other authorities on blood pressure determinations. (The new Fleischer stethoscope of Bakelite is particularly adaptable in connection with the Ausculatory method because of its adjustable bracelet which enables the physician to secure the stethoscope over the artery. The use of this stethoscope also enables the physician to check the ausculatory finding against that obtained by palpation.)

IMPORTANT - Before closing case, detach rubber tubing from reservoir and remove all air from the rubber bag. Fold loosely and place in bottom of case as illustrated.

Space is provided in left forward part of case for the bulb.

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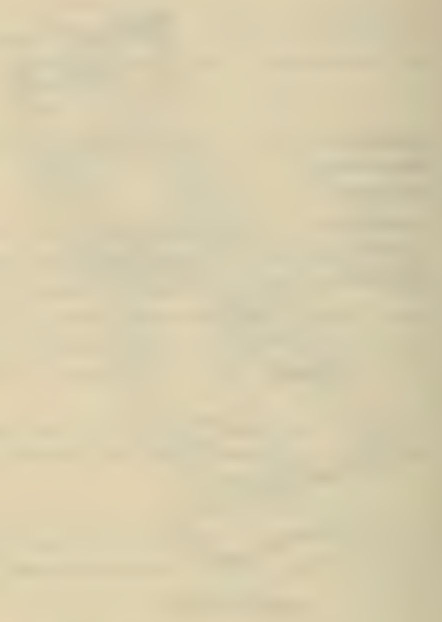

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CHAPTER III

DIAGNOSTIC EQUIPMENT

SECTION 3

BASAL METABOLISM

BASAL METABOLISM

INTRODUCTION

WHAT IS MEANT BY "BASAL METABOLISM"? - Metabolism in humans means the process of change in the body that supports life by first building up digested food into flesh, blood, muscle and energy, and then breaking them down to provide the heat needed by the body. In short, metabolism is broadly the whole building up and breaking down process of the body.

Metabolism is basal when the body is at rest and relaxed, free from mental disturbances and with no digesting food in the gastro-intestinal tract.

Oxygen is the medium for promoting this process of change, and hence the quantity used is an index of the rate at which the change is taking place - an index of the "rate of metabolism", or popularly, the rate of living.

HOW IS A METABOLISM TEST MADE? - The common method of making a metabolism test is what is known as the oxygen consumption method. It measures the quantity of oxygen that is actually consumed in a unit of time while the person is under basal conditions. There are other methods such as the chamber calorimeter and gas analysis that are adapted to special types of research but hardly practical for regular clinical use.

WHY IS A METABOLISM TEST MADE? - A metabolism test is made to find out how much the metabolism process is varying from its normal rate, in order to aid in diagnosing disease. The thyroid gland is the "regulator" of the metabolism process and hence the *rate* of metabolism is an index of the activity of the thyroid function. The metabolism test thus indicates thyroid condition.

WHAT IS THE VALUE OF A METABOLISM TEST? - The metabolism test is of value as an aid to diagnosis and treatment:

As a measure of the degree of thyro-toxocosis; an important fact to surgeons before an operation.

As an aid to differentiating by definitely ruling out thyroid when the rate, or BMR, is normal; the dangers of trial and error methods of treating and watching for improvement are thus avoided.

As a method of furnishing a definite basis for regulating medication or treatment; patient's progress may be accurately followed by repeating check tests at regular intervals and adjusting dosage accordingly.

McKESSON RECORDING WATER TYPE METABOLOR #176

UNPACK CAREFULLY - Upon receiving the apparatus, unpack carefully and make sure all parts are removed before discarding the packing material.

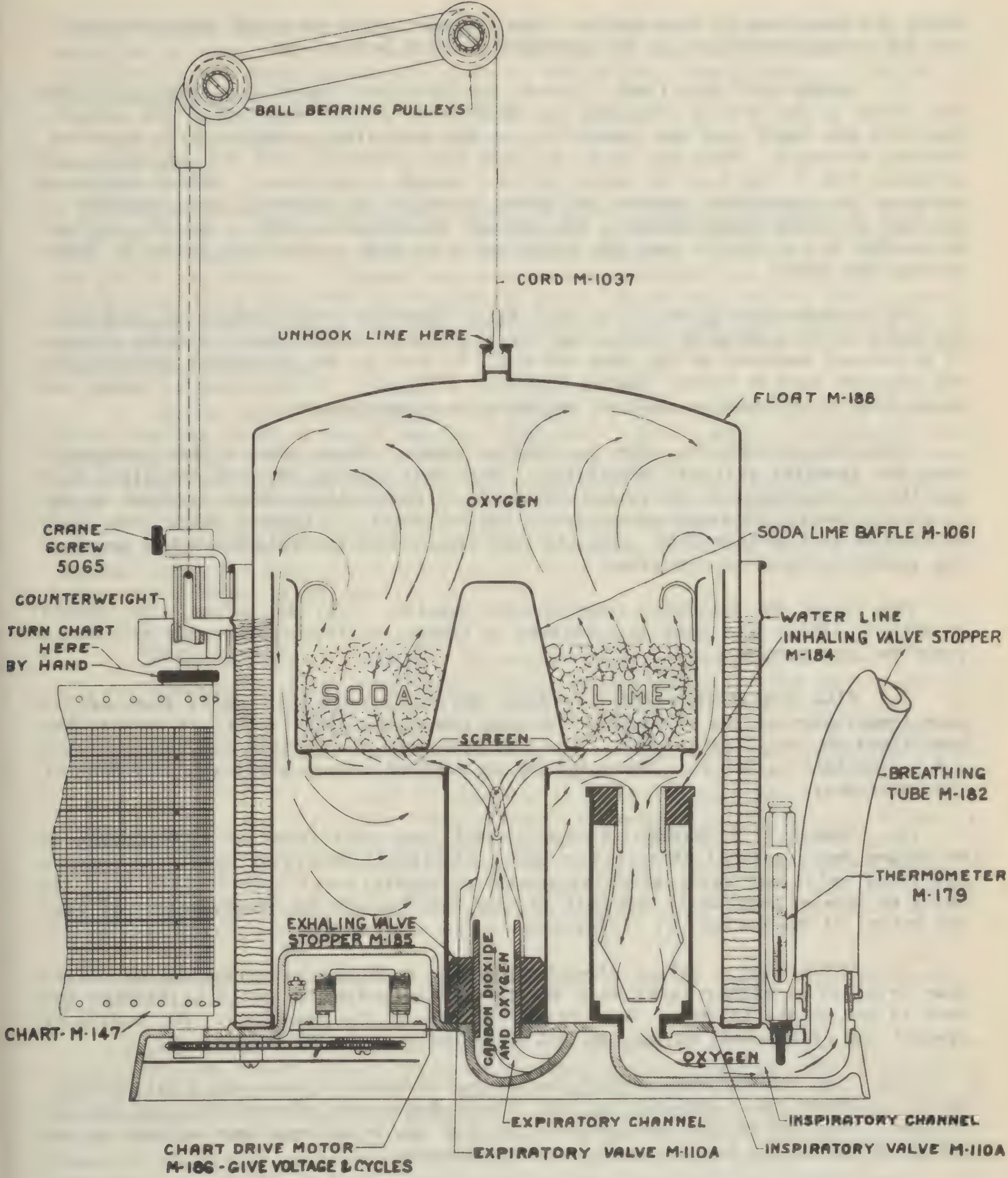
Place the apparatus on a table and follow the directions given below for preparing the apparatus for use.

NOTE - This apparatus operates on the electric current stamped on the name plate—usually 110-120 volts, 60 cycles, alternating current.

Making a metabolism test with this instrument consists of two procedures, namely—measuring the rate at which oxygen is absorbed by the patient, while inhaling oxygen to and fro in the apparatus; and computing the rate of oxidation or metabolism from the quantity of oxygen used in six minutes—the ordinary duration of a determination.

Measuring the rate of oxygen used is the primary function of the apparatus and

McKESSON RECORDING METABOLOR #176
WATER TYPE



McKESSON WATER TYPE METABOLOR #176

while the technique is very simple, care is required to make the test accurately. The following preparation of the apparatus is made before use:

1. CHARGE WITH SODA LIME - Unhook the line from the "bell", then swing the bell crane to the left by loosening the thumb screw at the lower end of the upright. Now lift the "bell" out and then lift out the soda-lime container by a twisting, rocking movement. Pour one quart of soda lime granules into the container and sprinkle with a few c.c. of water, but not enough to saturate. Before replacing the soda lime container, examine the rubber valve in the bottom of the apparatus to see that it stands perpendicular, then replace the container with a rotating motion. Be careful not to double over the rubber valve as then exhalations cannot be blown through the valve.

If the apparatus is not to be used for a number of hours, remove the soda lime and place it in a large bottle or the tin in which it was received, tightly closing it to prevent exposure to CO_2 from the air. If left in the instrument continuously the granules tend to "cake", making breathing difficult. If this occurs, remove and break it up into granules again or replace with fresh granules.

Soda lime absorbs CO_2 from the exhaled gases. There comes a time eventually when the granules will not absorb CO_2. When this occurs, the patient sighs frequently or progressively increases the depth of respiration, which is shown by the increasing length of respiratory strokes on the chart. A reading taken under such conditions will be incorrect. The old soda lime should be replaced with a quart of new granules, as above described.

Now attach the breathing tubes without inhaler. Test the valves. You should be able to easily blow into one, but not to inhale; while the other may be inhaled from, but not exhaled.

2. FILL MOAT WITH WATER - Replace the "bell" and pour water (having the same temperature as the room) into the moat around the "bell" until it reaches the bead about an inch from the top. Pass the line over the pulleys and reconnect the end to the bell as before. The water may be drained through a valve on the back of the instrument.

3. CHARGE WITH OXYGEN - Connect small tank yoke found on rubber tube to an oxygen tank, connect other end to valve at base of apparatus near thermometer. Open this valve and while allowing oxygen to slowly enter "bell" close shut off valve in inhaler body until the bell is near the top and the counterweight is near the bottom of the upright it slides over.

4. ADJUST PEN - Before starting a test, push pen rod attached to weight down until it is either level with the top of the weight or until it strikes the base if the weight is down. This brings the pen to the base line. Put a drop of special ink (furnished) in the pen and bring the pen against the paper.

N.B. - It will be noticed that the pen has a travel of four and a half liters, while the float has a capacity of six liters—hence the adjustability of the pen carrier. When the weight is up the pen carrier may be slipped down and out of the groove to remove the pen for cleaning when necessary.

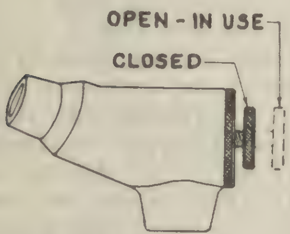
5. TO LEVEL THE APPARATUS - Two leveling screws on the base are provided to level the apparatus. Adjust until the bell hangs the same distance from the side of the moat all around.

6. START CHART RUNNING - Attach cord to electric light fixture and turn switch on at base. The chart now runs at the rate of one inch per minute. See that the holes in the paper engage the studs on the roller. Now breathe in and out of the apparatus to see that the pen writes.

To cut off chart used, turn electric switch off and pull chart against metal tear off strip.

A new apparatus comes with chart roll in place. Later when applying a new roll of paper, remove the old core from the upright holders, place new roll and glue paper to old paper, being careful that the holes coincide. Then turn on electricity and let it run through. If paper has been removed from the time roller, cut the end of the paper in a long "V" and thread the point around the roller, being careful that corresponding holes in the paper pass over the studs and turn the roller at the top with the fingers. When threaded over the roller, slip paper into the table grooves, top and bottom.

7. ADJUST UNIT AND INHALERS TO PATIENT - There are two sizes of face inhalers and two sizes of mouth inhalers furnished. Face inhalers are usually more comfortable than mouth inhalers. The smaller face inhaler is for women and children —the larger one for large men. The face inhalers are held in place by a harness about the head and snapped on with glove fasteners. It should be applied tight enough to fit airtight but not so tight as to be uncomfortable. The pneumatic cushion must not be blown up tight—just open the valve and air will fill the cushion properly, then close the valve to keep the air in. This should be done before the inhaler is put on.



INHALER Y

If it is difficult to adapt the face inhalers to a patient, the mouth inhalers (adult and children's sizes) may be preferred in some cases. The mouth inhaler flange fits under the lips and outside the teeth. The seal thus made is airtight as long as the patient co-operates to make it so. The nose must be clamped shut with the spring clip. Be sure it really holds the nose shut by applying it below the bony portion of the nose. The inhaler should be applied to the patient before it is connected to the inhaler body. After the inhaler is adjusted so that it makes an airtight adaptation to the patient, connect inhaler body to inhaler by bending the flexible metal tube support to bring the inhaler body into position to attach it to the inhaler without pull or stress on it.

PREPARATION OF PATIENT FOR METABOLISM TEST - DuBois states the fundamentals in the following lines:

"Many serious errors can be made in the management of the patient. In the first place one should assure perfect co-operation by explaining that the test is necessary and is for the patient's good. He must be instructed to take no food in the evening after 8 o'clock and nothing in the morning except a cup of caffeine-free coffee without milk or sugar. He should be brought to the laboratory without fatigue on his arrival weighed and measured to determine his height. (This may be done after test.) He must lie quietly for at least one-half hour before test. The mouth temperature should be taken and the pulse counted at intervals until it has assumed a basal level. The atmosphere of the room should be quiet and confident and there should be as little display of apparatus as possible. Visitors must be excluded. (Conversation avoided.)"

HOW TO RUN THE TEST - Having filled the soda lime container, and charged the apparatus with four or five liters of oxygen and applied the inhaler, as previously described, switch on the electric drive of the chart and allow the patient to breathe in and out four or five times. Then push the square rod carrying the pen down to the base, which puts the pen on the zero line of the chart.

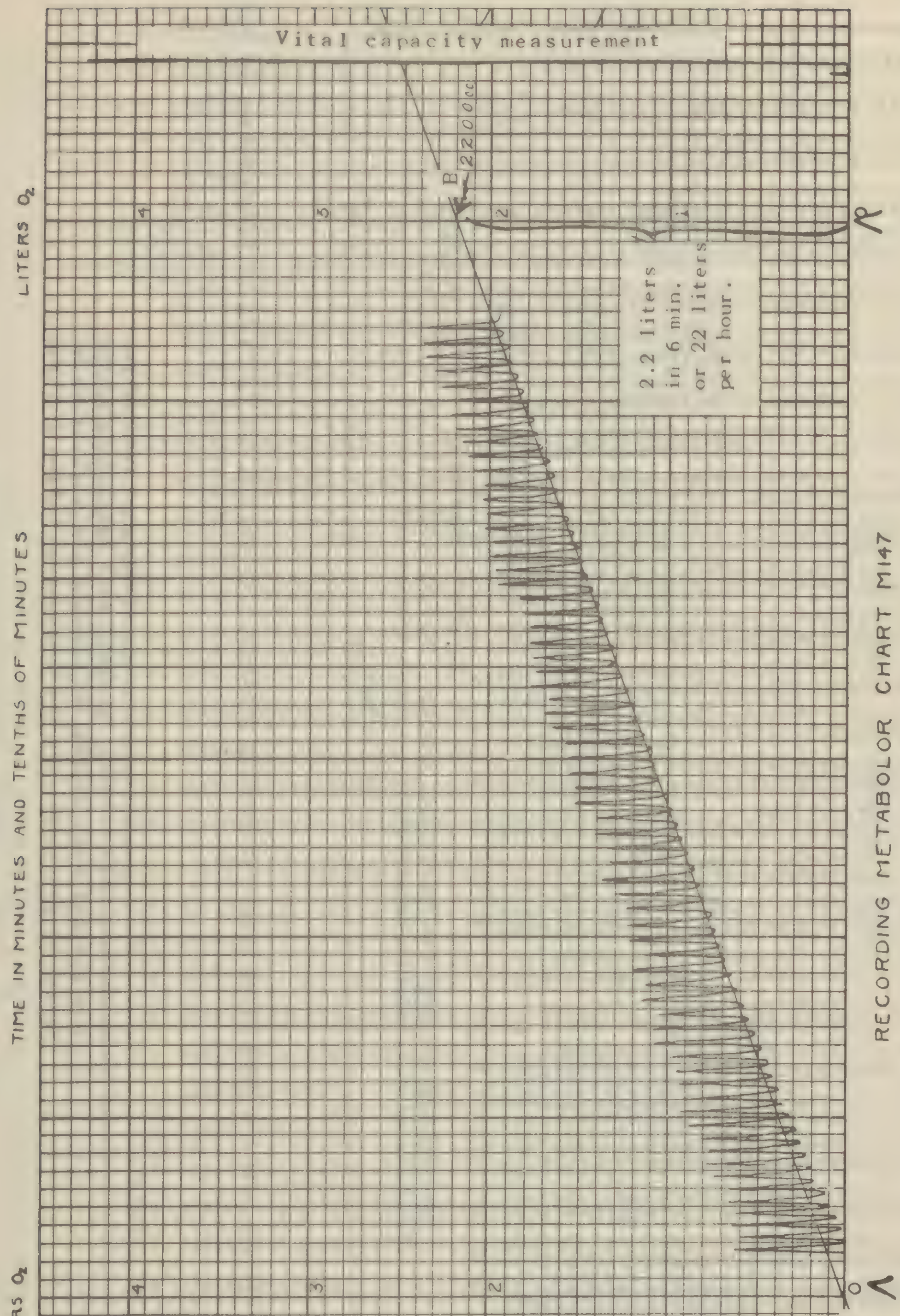
Instruct the patient to breathe regularly and uniformly relaxing as if going to sleep. As the patient absorbs the oxygen, the pen progressively rises. At the end of five or six minutes, remove the inhaler and let the patient remain quiet for a few minutes and repeat the test. Usually the second test is more uniform than the first, unless the patient has previously experienced a test.

Cut off the chart at least six inches (6 minutes), after the pen left the base (0) line. Record the temperature of the apparatus upon the chart and the reading of the barometer in millimeters. These two readings are necessary for corrections in Table A. Note also the height and weight of the patient on the chart. These are necessary for Table B. Note the age and sex of the patient on the chart; these are required in Table C. In addition, note your observation of the patient, whether relaxed, anxious, cooperative or otherwise and whether you regard conditions as satisfactory—if not, repeat the test another day. Note the temperature of the patient on the chart as a fever or subnormal temperature influences the metabolic rate and must be corrected for the final computation.

DRAW THE SLOPE OF THE OXYGEN CONSUMPTION - Place the record on a table and with a straight edge or ruler draw a straight line just under and paralled with or touching the lower points of the respiratory curves, as illustrated on sample chart, selecting that section of the record which is uniform in slope and appears to be most uniform in rate and shape, extending this line until it crosses the base line at the left and well beyond six inches (six minutes) in length to the right. This line is marked A-B. Now, beginning at the intersection of this sloped line with the base line, measure six inches to the right along the base line or count six large squares to the right for six minutes, marking the point. Perpendicular from this latter point and intersecting the sloped line, the quantity of oxygen in liters absorbed in six minutes is read off. By moving the decimal point one figure to the right, we have the quantity of oxygen used per hour. In other words, at the six-minute point, the distance which the sloped line is above the base line marks the quantity of oxygen used in six minutes, hence the slope of the curve indicates the rate of oxygen absorption. Heavy lines parallel with the base line marked 1, 2, 3, 4, indicate liters, and the thin lines, one-tenth of a liter or 100 c.c. each. Hence, in the illustration there were 2200 c.c. or 2.2 liters used in six minutes or the oxygen consumption was at the rate of 22 liters per hour (moving the decimal point one figure to the right, that is, multiplying by 10 since six minutes is 1/10 of an hour).

CALCULATIONS - Having determined the quantity of oxygen which the patient consumes per hour, a variety of methods may be employed to determine the percent below or above normal. But the following is the shortest and probably the most accurate comprising three tables and involving only one multiplication and one division. The steps are as follows:

A. *Multiply* the volume of oxygen consumed per hour as described above by a factor from Table A. The product represents the number of *calories of heat per hour* which this quantity of oxygen produces when burned in the body together with the necessary corrections made in the same factor for temperature, barometric pressure and aqueous vapor.



BASAL METABOLISM CALCULATIONS
EXAMPLE CHART

BASAL METABOLISM CALCULATIONS

Multiply oxygen consumption per hour expressed in liters by correction and conversion factor from Table A and divide by surface area Table B. Compare with Table C to get percent of Normal.

The following Tables A, B, C, E, are for use with McKesson Metabolors - #176 Water Type and #186 Waterless Type.

— TABLE A. —

THE CALORIFIC EQUIVALENT OF ONE LITER OF OXYGEN (4.825) COMBINED WITH FACTORS FOR REDUCTION OF VOLUMES TO 0°C., 760 M.M. PRESSURE AND 80% AQUEOUS VAPOR SATURATION.

TEMPERATURE °C.

BAROMETRIC PRESSURE IN M.M.	15	16	17	18	19	20	21	22	23	24	25
615	3.65	3.63	3.61	3.59	3.57	3.55	3.53	3.52	3.50	3.48	3.46
620	3.68	3.66	3.64	3.62	3.60	3.58	3.56	3.55	3.53	3.51	3.49
625	3.71	3.69	3.67	3.65	3.63	3.61	3.59	3.58	3.56	3.54	3.52
630	3.74	3.72	3.70	3.68	3.66	3.64	3.62	3.61	3.59	3.57	3.55
635	3.77	3.75	3.73	3.71	3.69	3.67	3.65	3.64	3.62	3.60	3.58
640	3.80	3.78	3.76	3.74	3.72	3.70	3.68	3.67	3.65	3.63	3.61
645	3.83	3.81	3.79	3.77	3.75	3.73	3.71	3.70	3.68	3.66	3.64
650	3.86	3.84	3.82	3.80	3.78	3.76	3.74	3.73	3.71	3.69	3.67
655	3.88	3.87	3.84	3.82	3.80	3.78	3.76	3.75	3.74	3.72	3.70
660	3.91	3.89	3.87	3.85	3.83	3.81	3.79	3.78	3.76	3.74	3.72
665	3.94	3.92	3.90	3.88	3.86	3.84	3.82	3.81	3.79	3.77	3.75
670	3.97	3.95	3.93	3.91	3.89	3.87	3.85	3.84	3.82	3.80	3.78
675	4.00	3.98	3.96	3.94	3.92	3.90	3.88	3.87	3.85	3.83	3.81
680	4.04	4.02	4.00	3.98	3.96	3.94	3.92	3.90	3.88	3.86	3.84
685	4.07	4.05	4.03	4.01	3.99	3.97	3.95	3.93	3.91	3.89	3.87
690	4.10	4.08	4.06	4.04	4.02	4.00	3.98	3.96	3.94	3.92	3.90
695	4.13	4.11	4.09	4.07	4.05	4.03	4.01	3.99	3.97	3.95	3.93
700	4.16	4.14	4.12	4.10	4.08	4.06	4.04	4.02	3.99	3.97	3.95
705	4.19	4.17	4.15	4.13	4.11	4.09	4.07	4.05	4.03	4.01	3.99
710	4.22	4.20	4.18	4.16	4.14	4.12	4.10	4.08	4.06	4.04	4.02
715	4.25	4.23	4.21	4.19	4.17	4.15	4.13	4.11	4.09	4.07	4.05
720	4.28	4.26	4.24	4.22	4.20	4.18	4.16	4.14	4.12	4.10	4.08
725	4.31	4.29	4.27	4.25	4.23	4.21	4.19	4.17	4.15	4.13	4.11
730	4.34	4.32	4.30	4.28	4.26	4.24	4.22	4.20	4.18	4.16	4.14
735	4.36	4.34	4.32	4.30	4.28	4.26	4.25	4.22	4.20	4.18	4.16
740	4.39	4.37	4.35	4.33	4.31	4.29	4.27	4.25	4.23	4.21	4.19
745	4.42	4.40	4.38	4.36	4.34	4.32	4.30	4.28	4.26	4.24	4.22
750	4.45	4.43	4.41	4.39	4.37	4.35	4.33	4.31	4.29	4.27	4.25
755	4.48	4.46	4.44	4.42	4.40	4.38	[illegible]	4.34	4.32	4.30	4.28
760	4.51	4.49	4.47	4.45	4.43	4.41	4.39	4.37	4.35	4.33	4.31
765	4.54	4.52	4.50	4.48	4.46	4.44	4.42	4.40	4.38	4.36	4.34
770	4.57	4.55	4.53	4.51	4.49	4.47	4.45	4.43	4.41	4.39	4.37
775	4.60	4.58	4.56	4.54	4.52	4.50	4.48	4.46	4.44	4.42	4.40
780	4.63	4.61	4.59	4.57	4.55	4.53	4.51	4.49	4.47	4.45	4.43

BAROMETRIC PRESSURE IN M.M.	26	27	28	29	30	31	32	33	34	35	36	37	38	
615	3.44	3.42	3.40	3.38	3.36	3.34	3.33	3.31	3.29	3.27	3.25	3.23	3.21	615
620	3.47	3.45	3.43	3.41	3.39	3.37	3.36	3.34	3.32	3.30	3.28	3.26	3.24	620
625	3.50	3.48	3.46	3.44	3.42	3.40	3.39	3.37	3.35	3.33	3.31	3.29	3.27	625
630	3.53	3.51	3.49	3.47	3.45	3.43	3.42	3.40	3.38	3.36	3.34	3.32	3.30	630
635	3.56	3.54	3.52	3.50	3.48	3.46	3.44	3.42	3.40	3.38	3.36	3.34	3.32	635
640	3.59	3.57	3.55	3.53	3.51	3.49	3.47	3.45	3.43	3.41	3.39	3.37	3.35	640
645	3.62	3.60	3.58	3.56	3.54	3.52	3.50	3.48	3.46	3.44	3.42	3.40	3.38	645
650	3.65	3.63	3.61	3.59	3.57	3.55	3.53	3.51	3.49	3.47	3.45	3.43	3.41	650
655	3.68	3.66	3.64	3.62	3.60	3.58	3.56	3.54	3.52	3.50	3.48	3.46	3.44	655
660	3.70	3.68	3.66	3.64	3.62	3.60	3.58	3.56	3.54	3.52	3.50	3.48	3.47	660
665	3.73	3.71	3.69	3.67	3.65	3.63	3.61	3.59	3.57	3.55	3.53	3.51	3.49	665
670	3.76	3.74	3.72	3.70	3.68	3.66	3.64	3.62	3.60	3.58	3.56	3.54	3.52	670
675	3.79	3.77	3.75	3.73	3.71	3.69	3.67	3.65	3.63	3.61	3.59	3.57	3.55	675
680	3.82	3.80	3.78	3.76	3.74	3.72	3.70	3.68	3.66	3.64	3.62	3.60	3.58	680
685	3.85	3.83	3.81	3.79	3.77	3.75	3.73	3.71	3.69	3.67	3.65	3.63	3.61	685
690	3.88	3.86	3.84	3.82	3.80	3.78	3.76	3.74	3.72	3.70	3.68	3.66	3.64	690
695	3.91	3.89	3.87	3.85	3.83	3.81	3.79	3.77	3.75	3.73	3.71	3.69	3.67	695
700	3.93	3.91	3.89	3.87	3.85	3.83	3.81	3.79	3.77	3.75	3.73	3.71	3.69	700
705	3.97	3.94	3.92	3.90	3.88	3.86	3.84	3.82	3.80	3.78	3.76	3.74	3.72	705
710	3.99	3.97	3.95	3.93	3.91	3.89	3.87	3.85	3.83	3.81	3.79	3.77	3.75	710
715	4.02	4.00	3.98	3.96	3.94	3.92	3.90	3.88	3.86	3.84	3.82	3.80	3.78	715
720	4.05	4.03	4.01	3.99	3.97	3.95	3.93	3.91	3.89	3.87	3.85	3.83	3.81	720
725	4.08	4.06	4.04	4.02	4.00	3.98	3.96	3.94	3.92	3.90	3.88	3.86	3.84	725
730	4.11	4.09	4.07	4.05	4.03	4.01	3.99	3.97	3.95	3.93	3.91	3.89	3.87	730
735	4.13	4.11	4.09	4.07	4.05	4.03	4.01	3.99	3.97	3.95	3.93	3.91	3.89	735
740	4.16	4.14	4.12	4.10	4.08	4.06	4.04	4.02	4.00	3.98	3.96	3.94	3.92	740
745	4.19	4.17	4.15	4.13	4.11	4.09	4.07	4.05	4.03	4.01	3.99	3.97	3.95	745
750	4.22	4.20	4.18	4.16	4.14	4.12	4.09	4.07	4.05	4.03	4.01	3.99	3.97	750
755	4.25	4.23	4.21	4.19	4.17	4.15	4.12	4.10	4.08	4.06	4.04	4.02	4.00	755
760	4.28	4.26	4.24	4.22	4.19	4.17	4.15	4.13	4.11	4.09	4.07	4.05	4.03	760
765	4.31	4.29	4.27	4.25	4.23	4.21	4.18	4.16	4.14	4.12	4.10	4.08	4.06	765
770	4.34	4.32	4.30	4.28	4.26	4.24	4.21	4.19	4.17	4.15	4.13	4.11	4.09	770
775	4.37	4.35	4.33	4.31	4.29	4.27	4.24	4.22	4.20	4.18	4.16	4.14	4.12	775
780	4.40	4.38	4.36	4.34	4.32	4.30	4.28	4.25	4.22	4.20	4.18	4.16	4.14	780

—TABLE B.—

SURFACE AREA IN SQUARE METERS

FROM FORMULA OF DUBOIS & DUBOIS.,
$A = W^{.425} \times H^{.725} \times 71.84.$

HEIGHT IN INCHES / WEIGHT IN POUNDS

WEIGHT IN POUNDS	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
40	.70	.71	.72	.74	.75	.76	.77	.78	.80	.81	.82	.83	.84	.86	.87	.88	.89	.90	.91
45	.74	.75	.76	.78	.79	.80	.81	.82	.84	.85	.86	.87	.88	.90	.91	.92	.93	.94	.96
50	.77	.78	.79	.81	.82	.83	.85	.86	.87	.88	.90	.91	.92	.94	.95	.96	.98	.99	1.00
55	.80	.82	.83	.84	.85	.87	.89	.90	.91	.92	.94	.95	.96	.98	.99	1.00	1.02	1.03	1.04
60	.83	.85	.86	.87	.88	.90	.92	.93	.94	.95	.97	.99	1.00	1.01	1.02	1.04	1.06	1.07	1.08
65	.86	.88	.89	.90	.91	.93	.94	.96	.98	1.00	1.01	1.03	1.04	1.05	1.06	1.08	1.10	1.11	1.12
70	.88	.90	.91	.93	.94	.96	.97	.99	1.01	1.03	1.04	1.06	1.07	1.08	1.09	1.11	1.13	1.14	1.15
75	.91	.93	.94	.96	.97	.99	1.00	1.02	1.04	1.06	1.07	1.09	1.10	1.12	1.13	1.15	1.17	1.18	1.19
80	.93	.95	.97	.98	1.00	1.02	1.03	1.05	1.07	1.09	1.10	1.12	1.13	1.15	1.16	1.18	1.20	1.21	1.22
85	.96	.98	1.00	1.01	1.03	1.05	1.06	1.08	1.10	1.12	1.13	1.15	1.16	1.18	1.19	1.21	1.23	1.24	1.25
90	.98	1.00	1.02	1.03	1.05	1.07	1.08	1.10	1.12	1.14	1.15	1.17	1.19	1.20	1.22	1.24	1.26	1.27	1.28
95	1.01	1.03	1.05	1.06	1.08	1.10	1.11	1.13	1.15	1.17	1.18	1.20	1.22	1.23	1.25	1.27	1.29	1.30	1.32
100	1.03	1.05	1.07	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.21	1.23	1.24	1.26	1.28	1.29	1.31	1.33	1.34
105	1.05	1.07	1.09	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.26	1.27	1.29	1.30	1.32	1.34	1.36	1.37
110	1.07	1.09	1.11	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.31	1.33	1.35	1.36	1.38	1.40
115	1.09	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.25	1.27	1.29	1.31	1.33	1.34	1.36	1.38	1.39	1.41	1.43
120	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.25	1.27	1.29	1.31	1.33	1.35	1.36	1.38	1.40	1.42	1.44	1.45
125	1.13	1.15	1.17	1.19	1.21	1.23	1.25	1.27	1.30	1.32	1.34	1.36	1.38	1.39	1.41	1.43	1.45	1.47	1.48
130	1.15	1.17	1.19	1.21	1.23	1.25	1.27	1.29	1.32	1.34	1.36	1.38	1.40	1.41	1.43	1.45	1.47	1.49	1.50
135	1.17	1.19	1.21	1.23	1.25	1.27	1.29	1.31	1.34	1.36	1.38	1.40	1.42	1.43	1.45	1.47	1.49	1.51	1.53
140	1.18	1.21	1.23	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.45	1.47	1.49	1.51	1.53	1.56
145	1.20	1.23	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.45	1.46	1.50	1.52	1.54	1.56	1.58
150	1.22	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.45	1.47	1.50	1.52	1.54	1.56	1.58	1.60
155	1.23	1.25	1.27	1.30	1.32	1.35	1.37	1.39	1.41	1.43	1.45	1.47	1.49	1.52	1.54	1.56	1.58	1.60	1.62
160	1.25	1.27	1.29	1.32	1.34	1.37	1.39	1.41	1.43	1.45	1.47	1.49	1.51	1.54	1.56	1.58	1.60	1.62	1.64
165	1.27	1.29	1.31	1.34	1.36	1.39	1.41	1.43	1.45	1.47	1.49	1.51	1.53	1.56	1.58	1.60	1.62	1.64	1.67
170	1.29	1.31	1.33	1.36	1.38	1.40	1.42	1.44	1.47	1.49	1.51	1.53	1.55	1.56	1.60	1.62	1.64	1.66	1.69
175	1.31	1.33	1.35	1.38	1.40	1.42	1.44	1.46	1.49	1.51	1.53	1.55	1.57	1.60	1.62	1.64	1.66	1.68	1.71
180	1.32	1.34	1.36	1.39	1.41	1.43	1.45	1.48	1.50	1.53	1.55	1.57	1.59	1.62	1.64	1.66	1.68	1.70	1.73
185	1.34	1.36	1.38	1.41	1.43	1.45	1.47	1.50	1.52	1.55	1.57	1.59	1.61	1.64	1.66	1.68	1.70	1.72	1.75
190	1.35	1.37	1.40	1.42	1.45	1.47	1.49	1.52	1.54	1.57	1.59	1.61	1.63	1.66	1.69	1.70	1.72	1.74	1.77
195	1.37	1.39	1.42	1.44	1.47	1.49	1.51	1.54	1.56	1.59	1.61	1.63	1.65	1.68	1.70	1.72	1.74	1.76	1.79
200	1.38	1.40	1.43	1.45	1.48	1.50	1.52	1.55	1.57	1.60	1.62	1.65	1.67	1.69	1.71	1.74	1.76	1.78	1.81
205	1.40	1.42	1.45	1.47	1.50	1.52	1.54	1.57	1.59	1.62	1.64	1.67	1.69	1.71	1.73	1.76	1.78	1.80	1.83
210	1.41	1.43	1.46	1.48	1.51	1.53	1.55	1.58	1.60	1.63	1.65	1.68	1.70	1.73	1.75	1.78	1.80	1.82	1.85
215	1.43	1.45	1.48	1.50	1.53	1.55	1.57	1.60	1.62	1.65	1.67	1.70	1.72	1.75	1.77	1.80	1.82	1.84	1.87
220	1.44	1.46	1.49	1.51	1.54	1.56	1.59	1.61	1.64	1.66	1.69	1.72	1.74	1.76	1.78	1.81	1.84	1.86	1.88
225	1.45	1.48	1.50	1.53	1.55	1.58	1.61	1.63	1.66	1.68	1.71	1.74	1.76	1.78	1.80	1.83	1.86	1.88	1.90
230	1.46	1.49	1.51	1.54	1.56	1.59	1.62	1.64	1.67	1.69	1.72	1.75	1.77	1.79	1.81	1.84	1.87	1.89	1.91
235	1.48	1.51	1.53	1.56	1.58	1.61	1.64	1.66	1.69	1.71	1.74	1.77	1.79	1.81	1.83	1.86	1.89	1.91	1.93
240	1.49	1.52	1.54	1.57	1.59	1.62	1.65	1.67	1.70	1.72	1.75	1.78	1.80	1.82	1.84	1.87	1.90	1.92	1.95
245	1.51	1.54	1.56	1.59	1.61	1.64	1.67	1.69	1.72	1.74	1.77	1.79	1.81	1.84	1.86	1.89	1.92	1.94	1.97
250	1.52	1.55	1.57	1.60	1.62	1.65	1.68	1.70	1.73	1.75	1.78	1.80	1.83	1.85	1.87	1.90	1.93	1.95	1.98
255	1.53	1.56	1.58	1.61	1.63	1.66	1.69	1.72	1.75	1.78	1.80	1.82	1.84	1.87	1.89	1.92	1.95	1.97	2.00
260	1.54	1.57	1.59	1.62	1.64	1.67	1.70	1.73	1.76	1.79	1.81	1.83	1.85	1.88	1.90	1.93	1.96	1.98	2.01
265	1.56	1.59	1.61	1.64	1.66	1.69	1.71	1.74	1.77	1.80	1.83	1.85	1.87	1.90	1.92	1.95	1.98	2.00	2.03
270	1.57	1.60	1.62	1.65	1.67	1.70	1.73	1.76	1.79	1.81	1.84	1.87	1.89	1.92	1.94	1.97	2.00	2.02	2.05
275	1.58	1.61	1.64	1.66	1.69	1.72	1.75	1.78	1.81	1.83	1.86	1.89	1.91	1.94	1.96	1.99	2.02	2.04	2.07
280	1.59	1.62	1.65	1.67	1.70	1.73	1.76	1.79	1.82	1.84	1.87	1.90	1.92	1.95	1.97	2.00	2.03	2.05	2.08
285	1.60	1.63	1.66	1.68	1.71	1.74	1.77	1.80	1.83	1.86	1.89	1.92	1.94	1.97	1.99	2.02	2.05	2.07	2.10
290	1.61	1.64	1.67	1.69	1.72	1.75	1.78	1.81	1.84	1.87	1.90	1.93	1.95	1.98	2.00	2.03	2.06	2.08	2.11
295	1.62	1.65	1.68	1.70	1.73	1.76	1.79	1.82	1.85	1.88	1.91	1.94	1.96	1.99	2.01	2.04	2.07	2.09	2.12

WEIGHT IN POUNDS	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
40	.92	.93	.94	.95	.97	.98	.99	1.00	1.01	1.02	1.03	1.04	1.06	1.07	1.08	1.09	1.10	1.11	1.12
45	.97	.98	.99	1.00	1.02	1.03	1.04	1.06	1.07	1.08	1.09	1.10	1.12	1.13	1.14	1.15	1.16	1.17	1.18
50	1.01	1.03	1.04	1.05	1.07	1.08	1.09	1.11	1.12	1.13	1.14	1.15	1.17	1.18	1.19	1.20	1.21	1.22	1.23
55	1.05	1.07	1.08	1.09	1.11	1.12	1.13	1.15	1.16	1.17	1.18	1.20	1.22	1.23	1.24	1.25	1.26	1.28	1.29
60	1.09	1.11	1.12	1.13	1.15	1.16	1.17	1.19	1.20	1.21	1.22	1.24	1.26	1.27	1.28	1.29	1.30	1.31	1.32
65	1.13	1.15	1.17	1.18	1.19	1.20	1.22	1.24	1.25	1.26	1.27	1.28	1.30	1.31	1.32	1.33	1.35	1.36	1.37
70	1.16	1.18	1.19	1.21	1.23	1.25	1.26	1.28	1.29	1.30	1.31	1.32	1.34	1.35	1.36	1.37	1.39	1.40	1.41
75	1.20	1.22	1.23	1.25	1.27	1.29	1.30	1.32	1.33	1.34	1.36	1.36	1.38	1.39	1.40	1.41	1.43	1.44	1.45
80	1.23	1.25	1.26	1.28	1.30	1.32	1.33	1.35	1.36	1.37	1.38	1.40	1.42	1.43	1.44	1.45	1.47	1.48	1.49
85	1.26	1.28	1.30	1.32	1.33	1.35	1.37	1.39	1.40	1.41	1.42	1.44	1.46	1.47	1.48	1.49	1.51	1.52	1.53
90	1.29	1.31	1.33	1.35	1.36	1.38	1.40	1.42	1.43	1.44	1.45	1.47	1.49	1.50	1.52	1.53	1.55	1.56	1.57
95	1.33	1.35	1.36	1.38	1.40	1.42	1.43	1.45	1.46	1.48	1.49	1.51	1.53	1.54	1.56	1.57	1.59	1.60	1.61
100	1.36	1.38	1.39	1.41	1.43	1.45	1.46	1.47	1.49	1.51	1.53	1.54	1.55	1.57	1.59	1.61	1.62	1.63	1.65
105	1.39	1.41	1.42	1.44	1.46	1.48	1.49	1.50	1.52	1.54	1.56	1.57	1.59	1.61	1.62	1.64	1.66	1.67	1.69
110	1.42	1.43	1.45	1.47	1.48	1.50	1.52	1.53	1.55	1.57	1.59	1.60	1.62	1.64	1.65	1.67	1.69	1.70	1.72
115	1.45	1.46	1.48	1.50	1.51	1.53	1.55	1.56	1.58	1.60	1.62	1.63	1.65	1.67	1.68	1.70	1.72	1.73	1.75
120	1.47	1.49	1.51	1.53	1.54	1.56	1.58	1.59	1.61	1.63	1.65	1.66	1.68	1.70	1.71	1.73	1.75	1.76	1.78
125	1.50	1.52	1.54	1.56	1.57	1.59	1.61	1.62	1.64	1.66	1.68	1.69	1.71	1.73	1.74	1.76	1.78	1.79	1.81
130	1.52	1.54	1.56	1.56	1.59	1.61	1.63	1.65	1.67	1.68	1.70	1.72	1.74	1.76	1.77	1.79	1.81	1.82	1.84
135	1.55	1.57	1.59	1.61	1.62	1.64	1.66	1.68	1.70	1.71	1.73	1.75	1.77	1.79	1.80	1.82	1.84	1.85	1.87
140	1.57	1.59	1.61	1.63	1.64	1.66	1.68	1.70	1.72	1.74	1.76	1.78	1.80	1.82	1.83	1.85	1.87	1.88	1.90
145	1.60	1.62	1.64	1.66	1.67	1.69	1.71	1.73	1.75	1.77	1.79	1.81	1.83	1.85	1.86	1.88	1.90	1.91	1.93
150	1.62	1.64	1.66	1.68	1.69	1.71	1.73	1.75	1.77	1.79	1.81	1.83	1.85	1.87	1.89	1.91	1.93	1.95	1.97
155	1.64	1.66	1.68	1.70	1.72	1.74	1.76	1.78	1.80	1.82	1.84	1.86	1.88	1.90	1.92	1.94	1.96	1.98	2.00
160	1.66	1.68	1.70	1.72	1.74	1.76	1.78	1.80	1.82	1.84	1.86	1.88	1.90	1.92	1.94	1.96	1.98	2.00	2.02
165	1.69	1.71	1.73	1.75	1.77	1.79	1.81	1.83	1.85	1.87	1.89	1.91	1.93	1.95	1.97	1.99	2.01	2.03	2.05
170	1.71	1.73	1.75	1.77	1.79	1.81	1.83	1.85	1.87	1.89	1.91	1.93	1.95	1.97	1.99	2.01	2.03	2.05	2.07
175	1.73	1.75	1.77	1.79	1.82	1.84	1.86	1.88	1.90	1.92	1.94	1.96	1.98	2.00	2.02	2.04	2.06	2.08	2.10
180	1.75	1.77	1.79	1.81	1.84	1.86	1.88	1.90	1.92	1.94	1.96	1.98	2.00	2.02	2.04	2.06	2.08	2.10	2.12
185	1.77	1.79	1.81	1.83	1.86	1.88	1.90	1.92	1.94	1.96	1.98	2.00	2.02	2.04	2.06	2.08	2.10	2.12	2.14
190	1.79	1.81	1.83	1.85	1.88	1.90	1.92	1.94	1.96	1.98	2.00	2.02	2.04	2.06	2.08	2.10	2.12	2.14	2.16
195	1.81	1.83	1.85	1.87	1.90	1.92	1.94	1.96	1.98	2.01	2.03	2.05	2.07	2.09	2.11	2.13	2.15	2.17	2.19
200	1.83	1.85	1.87	1.89	1.92	1.94	1.96	1.98	2.00	2.03	2.05	2.07	2.09	2.11	2.13	2.15	2.17	2.19	2.21
205	1.85	1.87	1.89	1.91	1.94	1.96	1.98	2.00	2.02	2.05	2.07	2.09	2.11	2.13	2.16	2.18	2.20	2.22	2.24
210	1.87	1.89	1.91	1.93	1.96	1.98	2.00	2.02	2.04	2.07	2.09	2.11	2.14	2.16	2.18	2.20	2.23	2.25	2.27
215	1.89	1.91	1.93	1.95	1.97	2.00	2.02	2.04	2.06	2.09	2.11	2.13	2.16	2.18	2.20	2.22	2.25	2.28	2.30
220	1.90	1.93	1.95	1.97	1.99	2.02	2.04	2.06	2.08	2.11	2.13	2.15	2.18	2.20	2.22	2.24	2.27	2.30	2.32
225	1.92	1.95	1.97	1.99	2.01	2.04	2.06	2.08	2.10	2.13	2.15	2.17	2.20	2.22	2.24	2.26	2.29	2.32	2.34
230	1.93	1.96	1.99	2.01	2.03	2.05	2.08	2.10	2.12	2.15	2.17	2.19	2.22	2.24	2.26	2.28	2.31	2.34	2.36
235	1.95	1.98	2.01	2.03	2.05	2.07	2.10	2.12	2.14	2.17	2.19	2.21	2.24	2.26	2.28	2.30	2.33	2.36	2.38
240	1.97	2.00	2.03	2.05	2.07	2.09	2.12	2.15	2.17	2.19	2.21	2.24	2.26	2.28	2.30	2.32	2.35	2.38	2.40
245	1.99	2.02	2.05	2.07	2.09	2.11	2.14	2.17	2.19	2.21	2.23	2.26	2.28	2.30	2.32	2.34	2.37	2.40	2.42
250	2.00	2.03	2.06	2.08	2.11	2.13	2.16	2.19	2.21	2.24	2.26	2.29	2.31	2.33	2.35	2.37	2.39	2.41	2.43
255	2.02	2.05	2.08	2.10	2.13	2.15	2.18	2.21	2.23	2.26	2.28	2.31	2.33	2.35	2.37	2.39	2.41	2.43	2.45
260	2.03	2.06	2.09	2.11	2.14	2.16	2.19	2.22	2.24	2.27	2.29	2.32	2.34	2.36	2.39	2.41	2.43	2.45	2.47
265	2.05	2.08	2.11	2.13	2.16	2.18	2.21	2.24	2.26	2.29	2.31	2.34	2.36	2.38	2.41	2.43	2.45	2.47	2.49
270	2.07	2.10	2.13	2.15	2.17	2.19	2.22	2.25	2.27	2.30	2.32	2.35	2.38	2.40	2.42	2.44	2.47	2.50	2.52
275	2.09	2.12	2.15	2.17	2.19	2.21	2.24	2.27	2.29	2.32	2.34	2.37	2.40	2.42	2.44	2.46	2.49	2.52	2.54
280	2.10	2.13	2.16	2.18	2.20	2.22	2.25	2.28	2.30	2.33	2.35	2.38	2.41	2.43	2.46	2.48	2.51	2.54	2.56
285	2.12	2.15	2.18	2.20	2.22	2.24	2.27	2.30	2.32	2.35	2.37	2.40	2.43	2.46	2.48	2.50	2.53	2.56	2.58
290	2.13	2.16	2.19	2.21	2.24	2.26	2.29	2.31	2.33	2.36	2.38	2.42	2.45	2.47	2.50	2.52	2.55	2.58	2.60
295	2.14	2.17	2.20	2.23	2.26	2.28	2.31	2.33	2.36	2.38	2.40	2.44	2.47	2.49	2.52	2.54	2.57	2.60	2.62

BASAL METABOLISM CALCULATIONS

TABLE C

Giving Metabolic Rate in Percent. Above or Below Normal from Calories Obtained

(Aub and DuBois Normal Standards, Cal. per Sq. M. per Hour)

CALORIES OBTAINED	AGE and SEX														
Males Age				70-80		60-70		50-60		40-50	20-40		18-20	16-18	14-16
Females Age	70-80	60-70	50-60		40-50	30-40	20-30		18-20			16-18		14-16	
Normal	33.0	34.0	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.5	40.0	41.0	43.0	46.0
20.0	-39	-41													
21.0	-36	-38	-40												
22.0	-33	-35	-37	-38	-39	-40									
23.0	-30	-32	-34	-35	-36	-37	-38	-39	-40						
24.0	-27	-29	-31	-32	-33	-34	-35	-36	-37	-38	-39	-40			
25.0	-24	-27	-29	-30	-31	-32	-33	-34	-35	-36	-37	-38	-40		
26.0	-21	-24	-26	-27	-28	-29	-30	-31	-32	-33	-34	-36	-38	-40	
27.0	-18	-21	-23	-24	-25	-26	-27	-28	-29	-30	-31	-32	-34	-37	-40
28.0	-15	-18	-20	-21	-22	-23	-24	-25	-26	-27	-29	-30	-32	-35	-39
29.0	-12	-15	-17	-18	-20	-21	-22	-23	-24	-25	-27	-28	-29	-32	-37
30.0	-9	-12	-14	-15	-17	-18	-19	-20	-21	-22	-24	-25	-27	-30	-35
31.0	-6	-9	-11	-13	-14	-15	-16	-17	-18	-19	-22	-23	-24	-28	-33
32.0	-3	-6	-9	-10	-11	-12	-14	-15	-16	-17	-19	-20	-22	-26	-30
33.0	0	-3	-6	-7	-8	-10	-11	-12	-13	-14	-17	-18	-19	-23	-28
34.0	+3	0	-3	-4	-6	-7	-8	-9	-11	-12	-14	-15	-17	-21	-26
35.0	+6	+3	0	-1	-3	-4	-5	-7	-8	-9	-12	-13	-15	-19	-24
36.0	+9	+6	+3	+1	0	-1	-3	-4	-5	-7	-9	-10	-12	-16	-22
37.0	+12	+9	+6	+4	+3	+1	0	-1	-3	-4	-6	-8	-10	-14	-20
38.0	+15	+12	+9	+7	+6	+4	+3	+1	0	-1	-4	-5	-7	-12	-17
39.0	+18	+15	+12	+10	+8	+7	+5	+4	+3	+1	-1	-3	-5	-10	-15
40.0	+21	+18	+14	+13	+11	+10	+8	+7	+5	+4	+1	0	-2	-7	-13
41.0	+24	+21	+17	+16	+14	+12	+11	+9	+8	+6	+4	+3	0	-5	-11
42.0	+27	+24	+20	+18	+17	+15	+14	+12	+11	+9	+6	+5	+2	-2	-9
43.0	+30	+26	+23	+21	+19	+18	+16	+15	+13	+12	+9	+8	+5	0	-7
44.0	+33	+29	+26	+24	+22	+21	+19	+17	+16	+14	+11	+10	+7	+2	-4
45.0	+36	+32	+29	+27	+25	+23	+22	+20	+18	+17	+14	+12	+10	+5	-2
46.0	+39	+35	+31	+30	+28	+26	+24	+23	+21	+19	+16	+15	+12	+7	0
47.0	+42	+38	+34	+32	+31	+29	+27	+25	+24	+22	+19	+17	+15	+9	+2
48.0	+45	+41	+37	+35	+33	+32	+30	+28	+26	+25	+22	+20	+17	+12	+4
49.0	+48	+44	+40	+38	+36	+34	+32	+31	+29	+27	+24	+23	+20	+14	+7
50.0	+52	+47	+43	+41	+39	+37	+35	+33	+32	+30	+27	+25	+22	+16	+9
51.0	+55	+50	+46	+44	+42	+40	+38	+36	+34	+33	+29	+28	+24	+19	+11
52.0	+58	+53	+48	+47	+44	+42	+41	+39	+37	+35	+32	+30	+27	+21	+13
53.0	+61	+56	+51	+49	+47	+45	+43	+42	+39	+38	+34	+33	+29	+23	+15
54.0	+64	+59	+54	+52	+50	+48	+46	+44	+42	+40	+37	+35	+32	+26	+17
55.0	+67	+62	+57	+55	+53	+51	+49	+47	+45	+43	+39	+38	+34	+28	+20
56.0	+70	+65	+60	+58	+55	+53	+51	+49	+47	+45	+42	+40	+37	+30	+22
57.0	+73	+68	+63	+61	+58	+56	+54	+52	+50	+48	+44	+43	+39	+33	+24
58.0	+76	+71	+66	+63	+61	+59	+57	+55	+53	+51	+47	+45	+41	+35	+26
59.0	+79	+74	+69	+66	+64	+62	+59	+57	+55	+53	+49	+48	+44	+37	+28
60.0	+82	+76	+72	+69	+67	+64	+62	+60	+58	+56	+52	+50	+47	+40	+30
61.0	+85	+79	+74	+72	+69	+67	+65	+63	+60	+58	+54	+53	+49	+42	+32
62.0	+88	+82	+77	+75	+72	+70	+68	+65	+63	+61	+57	+55	+51	+44	+34
63.0	+91	+85	+80	+77	+75	+73	+71	+68	+65	+64	+59	+57	+54	+47	+36
64.0	+94	+88	+83	+80	+78	+75	+73	+71	+68	+66	+62	+60	+56	+49	+39
65.0	+97	+91	+86	+83	+81	+78	+76	+73	+71	+69	+64	+63	+59	+51	+41
66.0	+100	+94	+89	+86	+83	+81	+78	+76	+74	+72	+67	+65	+61	+53	+43
67.0	+103	+97	+91	+89	+86	+84	+81	+79	+76	+74	+69	+67	+63	+56	+45
68.0	+106	+100	+94	+92	+89	+86	+84	+81	+79	+77	+72	+70	+66	+58	+48
69.0	+109	+103	+97	+94	+91	+89	+86	+84	+82	+79	+75	+72	+68	+60	+50
70.0	+112	+105	+100	+97	+94	+92	+89	+87	+84	+82	+77	+75	+71	+63	+52
71.0	+115	+108	+103	+100	+97	+95	+92	+89	+87	+84	+80	+77	+73	+65	+54
72.0	+118	+111	+106	+103	+100	+97	+95	+92	+89	+87	+82	+80	+76	+67	+57
73.0	+121	+114	+109	+106	+103	+100	+97	+94	+92	+90	+85	+82	+78	+70	+59
74.0	+124	+118	+111	+108	+106	+103	+100	+97	+95	+92	+87	+85	+81	+72	+61
75.0	+127	+121	+114	+111	+108	+105	+103	+100	+97	+95	+90	+87	+83	+74	+63
76.0	+130	+124	+117	+114	+111	+108	+105	+103	+100	+97	+92	+90	+86	+77	+65
77.0	+133	+126	+120	+117	+114	+111	+108	+105	+103	+100	+95	+92	+88	+79	+67
78.0	+136	+129	+123	+120	+117	+114	+111	+108	+105	+103	+97	+95	+90	+81	+70
79.0	+139	+132	+126	+123	+119	+116	+114	+111	+108	+105	+100	+97	+93	+84	+72
80.0	+142	+135	+129	+125	+122	+119	+116	+113	+111	+108	+103	+100	+95	+86	+74
81.0	+145	+138	+131	+128	+125	+122	+119	+116	+113	+110	+105	+103	+98	+88	+76
82.0	+148	+141	+134	+131	+128	+125	+122	+119	+116	+113	+108	+105	+100	+91	+78
83.0	+152	+144	+137	+134	+131	+127	+124	+121	+118	+116	+110	+107	+102	+93	+80
84.0	+155	+147	+140	+137	+133	+130	+127	+124	+121	+118	+113	+110	+105	+95	+83
85.0	+158	+150	+143	+139	+136	+133	+130	+127	+124	+121	+115	+112	+107	+98	+85
86.0	+161	+153	+146	+142	+139	+136	+132	+129	+126	+123	+118	+115	+110	+100	+87
87.0	+164	+156	+149	+145	+142	+138	+135	+132	+129	+126	+120	+117	+112	+102	+89
88.0	+167	+159	+151	+148	+144	+141	+138	+135	+132	+129	+123	+120	+115	+105	+91
89.0	+170	+162	+154	+151	+147	+144	+141	+137	+134	+131	+125	+122	+117	+107	+94

BASAL METABOLISM CALCULATIONS

TABLE E—*Boys and Girls*

Giving Metabolic Rate in Percent. Above or Below Normal from Calories Obtained

McKesson Computed Chart*

CALORIES OBTAINED	AGE AND SEX																	
Males Age ➤	13		12		11		10		9		8		7		6		5	
Females Age ➤		13		12		11		10		9		8		7		6		5
Normal ➤	47.1	42.	47.8	43.4	48.6	44.6	49.5	45.8	50.4	46.9	51.2	48.1	52.	49.3	52.7	50.7	53	51.6
24																		
25																		
26		-39		-40		-41												
27		-36		-38		-39		-41										
28	-41	-33	-41	-35		-37		-39		-40								
29	-38	-31	-39	-33	-40	-35	-41	-37		-38		-40		-41				
30	-36	-29	-37	-31	-38	-33	-39	-35	-41	-36	-41	-38		-39		-41		
31	-34	-26	-35	-28	-36	-30	-37	-32	-39	-34	-39	-36	-40	-37	-41	-39		-40
32	-32	-24	-33	-26	-34	-28	-35	-30	-37	-32	-37	-33	-38	-35	-39	-37	-40	-38
33	-30	-21	-31	-24	-32	-26	-33	-28	-35	-30	-35	-31	-37	-33	-37	-35	-38	-36
34	-28	-19	-29	-22	-30	-24	-31	-26	-33	-28	-34	-29	-35	-31	-35	-33	-36	-34
35	-26	-17	-27	-19	-28	-22	-29	-24	-31	-25	-32	-27	-33	-29	-34	-31	-34	-32
36	-24	-14	-25	-17	-26	-19	-27	-21	-29	-23	-30	-25	-31	-27	-32	-29	-32	-30
37	-22	-12	-23	-15	-24	-17	-25	-19	-27	-21	-28	-23	-29	-25	-30	-27	-30	-28
38	-19	-9	-20	-12	-22	-15	-23	-17	-25	-19	-26	-21	-27	-23	-28	-25	-28	-26
39	-17	-7	-18	-10	-20	-13	-21	-15	-23	-17	-24	-19	-25	-21	-26	-23	-26	-24
40	-15	-5	-16	-8	-18	-10	-19	-13	-21	-15	-22	-17	-23	-19	-24	-21	-25	-22
41	-13	-2	-14	-5	-16	-8	-17	-10	-19	-13	-20	-15	-21	-17	-22	-19	-23	-21
42	-11	0	-12	-3	-14	-6	-15	-8	-17	-10	-18	-13	-19	-15	-20	-17	-21	-19
43	-9	+2	-10	-1	-11	-4	-13	-6	-15	-8	-16	-11	-17	-13	-18	-15	-19	-17
44	-7	+5	-8	+2	-9	-1	-11	-4	-13	-6	-14	-9	-15	-11	-16	-13	-17	-15
45	-4	+7	-6	+4	-7	+1	-9	-2	-11	-4	-12	-6	-13	-9	-15	-11	-15	-13
46	-2	+10	-4	+6	-5	+3	-7	0	-9	-2	-10	-4	-12	-7	-13	-9	-13	-11
47	0	+12	-2	+8	-3	+5	-5	+3	-7	0	-8	-2	-10	-5	-11	-7	-11	-9
48	+2	+14	0	+11	-1	+8	-3	+5	-5	+2	-6	0	-8	-3	-9	-5	-9	-7
49	+4	+17	+3	+13	+1	+10	-1	+7	-3	+4	-4	+2	-6	-1	-7	-3	-8	-5
50	+6	+19	+5	+15	+3	+12	+1	+9	-1	+7	-2	+4	-4	+1	-5	-1	-6	-3
51	+8	+21	+7	+18	+5	+14	+3	+11	+1	+9	0	+6	-2	+3	-3	+1	-4	-1
52	+10	+24	+9	+20	+7	+17	+5	+14	+3	+11	+2	+8	0	+5	-1	+3	-2	+1
53	+13	+26	+11	+22	+9	+19	+7	+16	+5	+13	+4	+10	+2	+8	+1	+5	0	+3
54	+15	+29	+13	+25	+11	+21	+9	+18	+7	+15	+6	+12	+4	+10	+3	+7	+2	+5
55	+17	+31	+15	+27	+13	+23	+11	+20	+9	+17	+7	+14	+6	+12	+4	+8	+4	+7
56	+19	+33	+17	+29	+15	+25	+13	+22	+11	+19	+9	+16	+8	+14	+6	+10	+6	+9
57	+21	+36	+19	+32	+17	+28	+15	+24	+13	+22	+11	+19	+10	+16	+8	+12	+8	+10
58	+23	+38	+21	+34	+19	+30	+17	+27	+15	+24	+13	+21	+12	+18	+10	+14	+9	+12
59	+25	+41	+23	+36	+21	+32	+19	+29	+17	+26	+15	+23	+14	+20	+12	+16	+11	+14
60	+27	+43	+26	+38	+23	+35	+21	+31	+19	+28	+17	+25	+15	+22	+14	+18	+13	+16
61	+30	+45	+28	+41	+25	+37	+23	+33	+21	+30	+19	+27	+17	+24	+16	+20	+15	+18
62	+32	+48	+30	+43	+28	+39	+25	+35	+23	+32	+21	+29	+19	+26	+18	+22	+17	+20
63	+34	+50	+32	+45	+30	+41	+27	+38	+25	+34	+23	+31	+21	+28	+20	+24	+19	+22
64	+36	+52	+34	+48	+32	+43	+29	+40	+27	+36	+25	+33	+23	+30	+21	+26	+21	+24
65	+38	+55	+36	+50	+34	+46	+31	+42	+29	+39	+27	+35	+25	+32	+23	+28	+23	+26
66	+40	+57	+38	+52	+36	+48	+33	+44	+31	+41	+29	+37	+27	+34	+25	+30	+25	+28
67	+42	+59	+40	+55	+38	+50	+35	+46	+33	+43	+31	+39	+29	+36	+27	+32	+26	+30
68	+44	+62	+42	+57	+40	+53	+37	+49	+35	+45	+33	+41	+31	+38	+29	+34	+28	+32
69	+46	+64	+44	+59	+42	+55	+39	+51	+37	+47	+35	+43	+33	+40	+31	+36	+30	+34
70	+49	+67	+47	+61	+44	+57	+41	+53	+39	+49	+37	+46	+35	+42	+33	+38	+32	+36
71	+51	+69	+49	+64	+46	+59	+43	+55	+41	+51	+39	+48	+37	+44	+35	+40	+34	+38
72	+53	+71	+51	+66	+48	+62	+45	+57	+43	+54	+41	+50	+38	+46	+37	+42	+36	+40
73	+55	+74	+53	+68	+50	+64	+47	+59	+45	+56	+43	+52	+40	+48	+39	+44	+38	+41
74	+57	+76	+55	+71	+52	+66	+49	+62	+47	+58	+45	+54	+42	+50	+40	+46	+40	+43
75	+59	+79	+57	+73	+54	+68	+52	+64	+49	+60	+47	+56	+44	+52	+42	+48	+42	+45
76	+61	+81	+59	+75	+56	+71	+54	+66	+51	+62	+49	+58	+46	+54	+44	+50	+43	+47
77	+63	+83	+61	+78	+58	+73	+56	+68	+53	+64	+50	+60	+48	+56	+46	+52	+45	+49
78	+66	+86	+63	+80	+61	+75	+58	+70	+55	+66	+52	+62	+50	+58	+48	+54	+47	+51
79	+68	+88	+65	+82	+63	+77	+60	+73	+57	+69	+54	+64	+52	+60	+50	+56	+49	+53
80	+70	+90	+67	+85	+65	+79	+62	+75	+59	+71	+56	+66	+54	+62	+52	+58	+51	+55
81	+72	+93	+69	+87	+67	+82	+64	+77	+61	+73	+58	+68	+56	+64	+54	+60	+53	+57
82	+74	+95	+72	+89	+69	+84	+65	+79	+63	+75	+60	+70	+58	+66	+56	+62	+55	+59
83	+76	+98	+74	+91	+71	+86	+68	+81	+65	+77	+62	+73	+60	+68	+58	+64	+57	+61
84	+78	+100	+76	+94	+73	+88	+70	+83	+67	+79	+64	+75	+62	+70	+59	+66	+58	+63
85	+80	+102	+78	+96	+75	+91	+72	+86	+69	+81	+66	+77	+63	+72	+61	+68	+60	+65
86	+83	+105	+80	+98	+77	+93	+74	+88	+71	+83	+68	+79	+65	+74	+63	+70	+62	+67
87	+85	+107	+82	+100	+79	+95	+76	+90	+73	+86	+70	+81	+67	+76	+65	+72	+64	+69
88	+87	+110	+84	+103	+81	+97	+78	+92	+75	+88	+72	+83	+69	+78	+67	+74	+66	+71
89	+89	+112	+86	+105	+83	+100	+80	+94	+77	+90	+74	+85	+71	+81	+69	+76	+68	+72
90	+91	+114	+88	+108	+85	+102	+82	+97	+79	+92	+76	+87	+73	+83	+71	+78	+70	+74

* Based on DuBois Standards as modified by Boothby and Sandiford...Prelim report Am. J. Physiol. 1929. 90,291.

BASAL METABOLISM CALCULATIONS

B. *Divide* the calories per hour obtained in (A) by the surface area of the patient obtained from Table B. The quotient is the number of calories per hour per square meter of body surface.

C. In order to determine what per cent the quotient from (B) is above or below normal, compare with Table C without computation.

ILLUSTRATIVE EXAMPLE-STEP (A) - Suppose the patient consumes 20 liters of oxygen per hour and the temperature of the apparatus during the test was 20°C. while the barometer stood at 690 mm. Hg. Referring to Table A, at the intersection of the temperature (20) and barometric columns (690) will be found the factor, 4.00 hence 20 x 4. = 80 calories per hour.

STEP (B) - Now, suppose the patient weighed 180 pounds and was 71 inches in height, referring to Table B at the intersection of these two rows of figures we find the patient's surface area to be two square meters. Then 80 calories per hour ÷ 2 square meters = 40 calories per square meter per hour.

STEP (C) - To find if this 40 calories per square meter per hour is greater or smaller than the normal and how much when expressed in percent, we use Table C. Suppose the patient is a woman, aged 34 (find Female's ages 30 to 40 in the sixth perpendicular column), follow this column down to a point opposite 40 found in the first column, left margin, or (the number of calories obtained in B) and we find the number + 10. Therefore, this patient has a metabolic rate of 10 per cent above normal as indicated by the plus sign before the number. The *normal* basal metabolic rate for this patient would have been 36.5, as found in the third horizontal column of figures in Table C.

Mathematical calculations may be eliminated by using calculator furnished.

FEVER INCREASES METABOLIC RATE - Now since plus 10% is the upper limit of normal range, and minus 10% is the lower limit, this patient may be a borderline case, although within normal limits. At other times, she may show higher readings and require more tests. On the other hand, if she had a fever of 1° F. the fever which adds 7.2% per degree is probably fully responsible for making the metabolic rate border upon the abnormal. Hence, in such event the + 10% - 7.2% = 2.8%, the actual metabolic rate for this patient at this test. For subnormal temperature add 7.2% per degree.

For boys and girls, use Table E instead of Table C.

REFERENCES - For further information on the use of basal metabolism in diagnosis, the user is referred to a book, "*Basal Metabolism in Health and Disease,*" DuBois, published by Lea & Febinger. It contains references to the literature on the subject up-to-date for those who wish to learn of the development, history, etc., of basal metabolism.

PARTS LIST - For No. 176 Metabolor

Part No.	
177	Stand for No. 176 Unit
178	Barometer as used with No. 176 Unit
180	Carrying Case with provision for carrying Barometer and Equipment. Black Pebble Leather Finish
M103	Soda Lime, Quart Can
M147	Chart Roll

M155A Ink (oiled)
182 Breathing Tube (Special) Length 28"
820 Face Hood (Men)
821 Face Hood (Women & Children's Size)
852 Face Hood Harness
3216 Mouth Inhaler (Adult Size)
3217 Mouth Inhaler (Child's Size)
194 Inhaler Body
M46 Nose Clamp
M110A Rubber Breathing Valves
179 Thermometer in Metal Case
181 Tank Yoke with Rubber Tube
183 Pen for No. 176 Metabolor
184 Rubber Inhaling Valve Stopper with Metal Tube
185 Rubber Exhaling Valve Stopper with Metal Tube
186 Synchronous Electric Motor (for Driving chart)
110 v. A.C. 60 cyls.
189 Synchronous Electric Motor (for Driving chart)
110 v. 50 cyls.
188 Oxygen Bell Float

SERVICE SUGGESTIONS FOR #176 WATER TYPE METABOLOR

WHEN SODA LIME SHOULD BE CHANGED - Soda Lime is used for removing the exhaled Carbon Dioxide. When the Soda Lime becomes exhausted, evidence of Carbon Dioxide accumulating will show on the chart. This is shown by the patient's breathing getting progressively deeper with each breath. That is, each of the up and down marks on the graph will get a little longer with each breath. Evidence of Carbon Dioxide will not ordinarily show until the patient has been breathing at least two minutes, (two inches horizontally on the chart paper).

When Carbon Dioxide is accumulating, the patient notices a sensation of difficult breathing especially at the latter part of the test.

If Carbon Dioxide has accumulated a low test would result.

How to change Soda Lime is explained in the regular instructions.

OTHER THINGS THAT CAUSE CARBON DIOXIDE TO ACCUMULATE - Flutter type breathing valves are standing open. These sometimes become cured in the open position and should be pinched inward where they connect to the tubular connection. At other times a granule of Soda Lime will hang in one of the valves, holding it open.

Soda Lime canister is not seated firmly. After putting the canister to place, it should be given a slight twist to seat it firmly.

The flutter valves are very easy to examine by looking inside the unit. Another way to check their operation, with bell about half filled with oxygen, disconnect the metal inhaler body at the mask connection and while holding your hand over the end of one of the breathing tubes, try to breathe back and forth into the other breathing tube. Watch the pen during this test. It should go in one direction only. Should you be able to breathe to and fro through one of the tubes, that would indicate the flutter valve on that side of the breathing system is defective or standing open.

IF WATER GETS INSIDE OF UNIT - Ordinarily a person would think there was

a leak between the water moat and the inside compartment. This is very seldom the case, as in almost every instance the machine has been handled improperly

THINGS THAT WILL CAUSE WATER TO GET INSIDE UNIT

1. Pulling bell up too rapidly. This bell should be pulled up very *slowly* when inhaler body valve at mark is open and should *never* be pulled up when this valve is closed.

2. Over-filling the moat with water. It should never be filled above the bead.

3. If breathing valve is stuck under Soda Lime and bell is lifted.

4. If the inside cap on the Soda Lime screen has become unsoldered from the screen and has fallen over the breathing area (This will not happen on any machine manufactured since 1940).

5. Rolling the machine over door stops, etc.

6. If machine is unbalanced and bell is scraping sides. In such a case the bell would pick up water on the upward stroke and scrape it into the center on downward stroke.

7. A very small amount of water will accumulate in the extreme bottom (below breathing tube connections) of the machine. To remove this, disconnect breathing tubes, tilt machine and remove water with an eye dropper.

IF PEN STAYS AT BOTTOM DURING TEST - This can be caused by:

1. Spring clip that holds pen assembly has been bent so the whole assembly drops down.

To correct this, remove both screws that hold spring clip. Bend the spring at the end that touches pen staff and replace.

2. Crane has not been placed high enough. The knurled screw which locks crane should be inserted in the hole in the crane upright.

3. String is too long. (See "To Replace String".)

4. Bell has been overfilled with oxygen. This bell should be filled with oxygen until the pen hits the bottom, however, the weight to which the pen is attached should lack about one inch of hitting the bottom.

5. A bad leak, such as inhaler body valve at mask not completely opened out.

6. Oxygen valve is left open and tank valve is not completely off.

HOW TO CLEAN PEN - Sometimes the operator will overfill the pen with ink and it will run down in the hinge of the pen. After the ink dries, the hinge will work stiff, making the pen dig into the paper, or will not write properly.

With string attached, push the bell down to the bottom. This will bring the weight and pen assembly to the top. Grasp the lower part of the pen assembly and pull it STRAIGHT down, NOT to the side. Remove the small screw that holds the pen and clean the male and female parts of the hinge with brush and water. In replacing pen, adjust it so it will drop freely but has very little side play. Adjust the backstop so that it stops the backward swing of the pen just after it falls

back of the top center. In replacing pen assembly, push it STRAIGHT up into the weight.

TO REPLACE A STRING - Disconnect string from bell. Unscrew thumbscrew and pull crane with pulleys straight up. The old string with metal tip will feed through the hollow part of the crane. Have someone hold the weight at the top or put a stick under the weight so it will stay at the top, cut old string from eye in top of weight and tie new one to place. Don't leave excess string after knot is tied. BE SURE THE EYE IS EXACTLY IN THE CENTER. Feed new string back through the hollow part of the crane. Put crane to place. BE SURE THE THUMBSCREW THAT HOLDS THE CRANE GOES INTO THE HOLE IN THE CRANE. A slightly depressed groove in the crane will help you gauge this. This hold helps center the pulleys and puts them at the right height. Thread the string into the metal tip. Cut the string on an angle and it will go easily. With weight still at the top and bell at the bottom, place the string over the pulleys, set the metal tip on the string so that it just goes into the slot in the bell. Bend the string sharply so as to mark it at this point and tie a knot there. Cut off excess string.

IF PAPER HANGS IN GUIDE - Check to be sure the perforated holes are meshing properly with the small studs on the roller. Be sure no sharp corners on the guide plate are catching in the perforations. ADJUST GUIDE PLATE UNTIL SURFACE IS PARALLEL WITH TOP OF ROLL. Be sure roll of paper is not sticking before it gets to the roller. NEVER OIL THE ROLLERS. Paper shoes which hold paper up to feed roller should be adjusted so that there is even clearance between shoe and roller.

McKESSON RECORDING WATERLESS TYPE METABOLOR #186

UNPACK CAREFULLY - Upon receiving the apparatus, unpack carefully and make sure all parts are removed before discarding the packing material.

Place the apparatus on table and assemble as indicated by the directions of the complete unit. Follow the directions given below for preparing the apparatus for use.

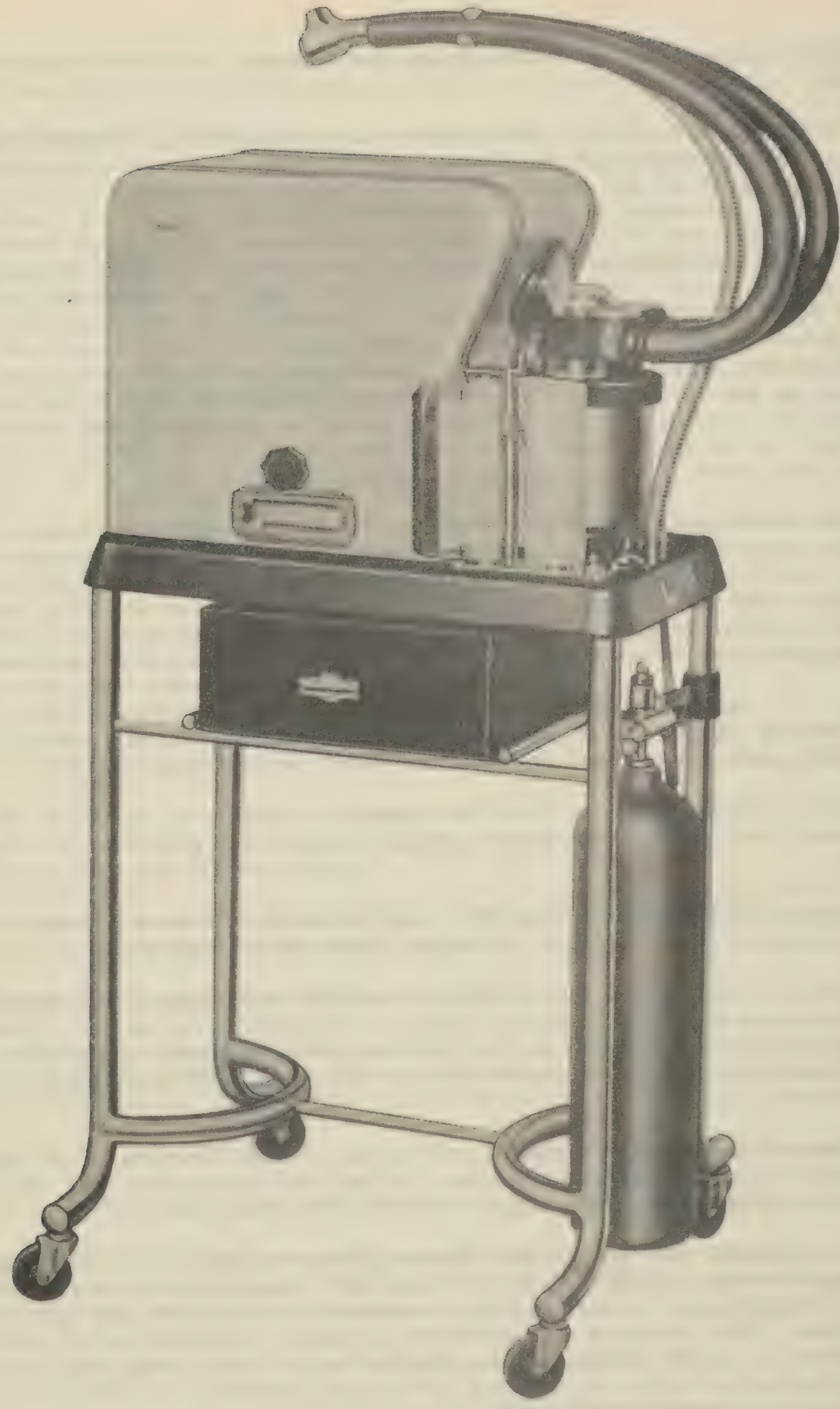
NOTE - This apparatus operates on the electric current stamped on the name plate--usually 110-120 volts, 60 cycles, alternating current.

Making a metabolism test with this instrument consists of two procedures, namely--measuring the rate at which oxygen is absorbed by the patient, while inhaling oxygen to and fro in the apparatus; and computing the rate of oxidation or metabolism from the quantity of oxygen used in six minutes--the ordinary duration of a determination.

Measuring the rate of oxygen used is the primary function of the apparatus and while the technic is very simple, care is required to make the test accurately. The following preparation of the apparatus is made before use:

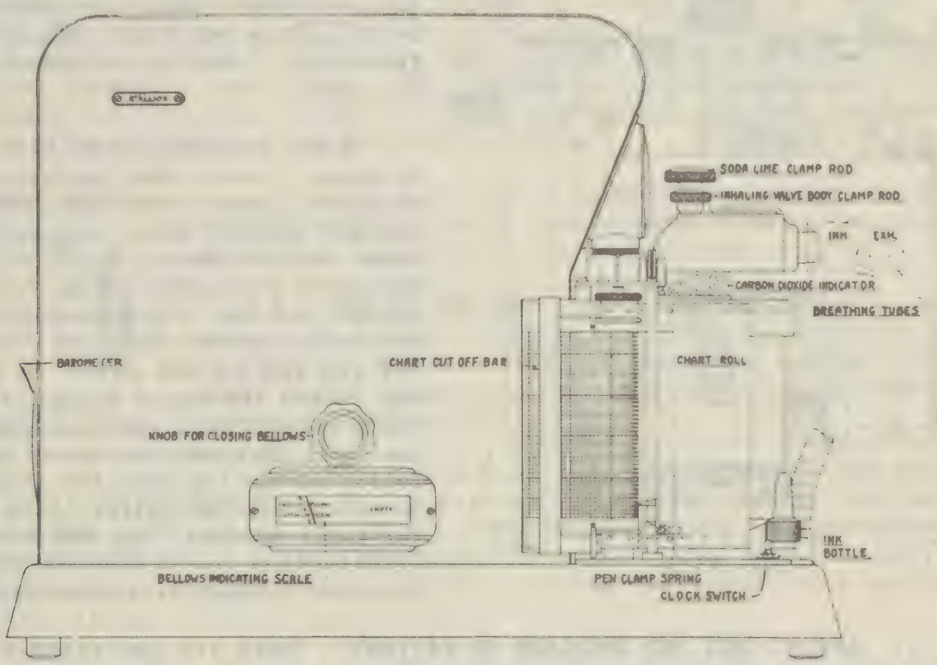
1. CHARGE WITH SODA LIME - Remove absorber clamp rod and slide soda lime container to rear of the instrument then, fill completely with Metabolor soda lime in metal container. In opening the quart can of soda lime, you will find a small metal box. This contains the indicator granules. Set this aside until soda lime container is filled and clamped securely in position by clamp rod.

2. SODA LIME INDICATOR - The soda lime indicator container is a small glass receptacle under the inhaling valve body. To remove this container for filling, simply remove the clamp rod which holds this assembly in place and fill completely with indicator granules, which will be found in the small metal box inside the



McKESSON RECORDING WATERLESS METABOLOR #186

quart can of soda lime. The function of the indicator is to determine when the soda lime has become saturated with carbon dioxide. The granules will change color when soda lime or baralyme is exhausted. It is not necessary to change the soda lime until granules have all changed color. Be sure string is over pulley.

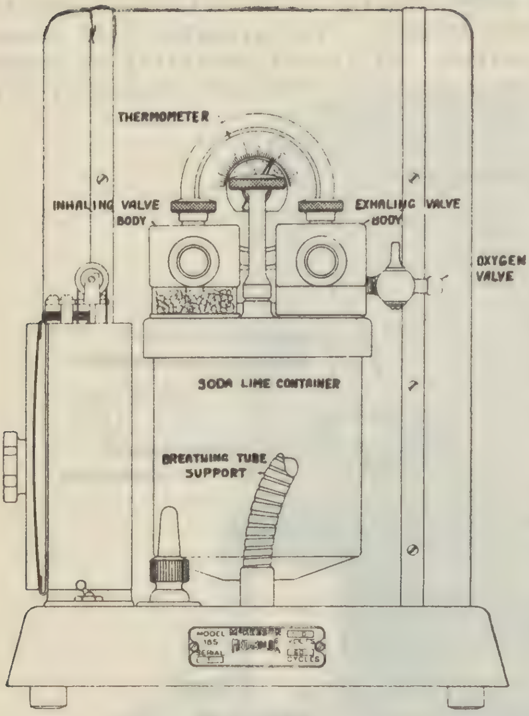


SIDE VIEW

3. CHARGE WITH OXYGEN - First place the cylinder of oxygen in the stand and connect yoke to cylinder valve and the other end of the rubber tube to the small oxygen inlet valve on the exhaling valve body. Then check position of red hand on bellows indicator scale to see if the bellows is empty. If not, turn black bakelite knob to the right or clockwise and empty bellows. Then close valve on inhaler body by turning the thumbscrew "in" to the right as far as it will go. *Now open oxygen valve on exhaling valve body*, (be sure to do this to prevent oxygen from blowing the tubing off by high oxygen pressure) and very carefully open valve on oxygen cylinder with the tank wrench provided until oxygen is admitted slowly into the Metabolor, when the red hand on the bellows indicator scale reaches the line marked "fill with O_2 to this line" shut off cylinder valve also oxygen inlet valve on exhaling valve body of the Metabolor.

4. ADJUST PEN - Before starting the test, but after the bellows has been filled with oxygen adjust pen to base line of chart by pressing out on pen clamp spring to free carriage from cord and slide pen carriage unit until pen point is on the base line.

Then pen is filled with ink by means of a dropper from the ink bottle which is carried by rubber grommet in base. This small service ink bottle is filled from larger one supplied with the unit. The ink furnished is a free-flowing oiled ink especially prepared to prevent clogging and for best results we suggest you do not substitute.



END VIEW

5. START CHART RUNNING - Attach cord to electrical outlet and snap clock switch on base making sure the current is A.C. and that the voltage and cycles stamped on name plate agree with your current. If attached to any other current than that indicated, chart drive motor will not operate satisfactorily. *Not to be used on direct current.*

A new apparatus comes with chart roll in place. Later, when applying a new roll of paper, remove the old core from the upright holder, place new roll and glue paper to old paper, being careful that the holes coincide. Then turn on electricity and let it run through. If paper has been removed from the time roller, cut the end of the paper in a long "V" and thread the point around the roller, being careful that corresponding holes in the paper pass over the studs and turn the roller at the top with the fingers. When threaded over the roller, slip paper into the table grooves, top and bottom. (See Illustration for sketch of how paper is threaded through drive mechanism).

6. ADJUST UNIT AND INHALERS TO PATIENT - There are two sizes of face inhalers and two sizes of mouth inhalers furnished. Face inhalers are susally more comfortable than mouth inhalers. The smaller face inhaler is for women and children—the larger one for large men. The face inhalers are hold in place by a harness about the head and snapped on with glove fasteners. It should be applied tight enough to fit air-tight but not so tight as to be uncomfortable. The pneumatic cushion must not be blown up tight—just open the valve and air will fill the cushion properly. Then close the valve to keep the air in. This should be done before the inhaler is put on.

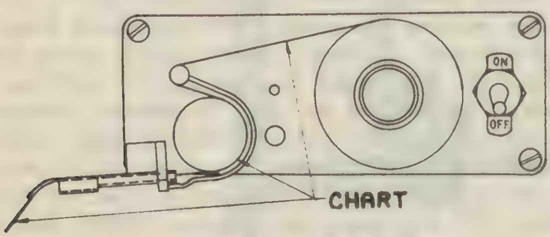
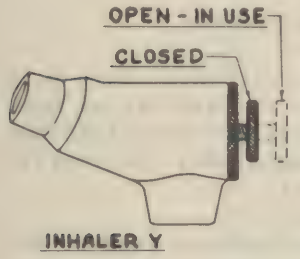


CHART DRIVE

If it is difficult to adapt the face inhalers to a patient, the mouth inhalers (adult and children's sizes) may be preferred in some cases. The mouth inhaler flange fits under the lips and outside of the teeth. The seal thus made is air-tight as long as the patient cooperates to make it so. The nose must be clamped shut with the spring clip. Be sure it really holds the nose shut byapplying it below the bony portion of the nose. The inhaler should be applied to the patient before it is connected to the inhaler body. After the inhaler is adjusted so that it makes an air-tight adaptation to the patient, connect inhaler body to inhaler by bending the flexible metal tube support to bring the inhaler body into position to attach it to the inhaler without pull or stress on it.

7. PREPARATION OF PATIENT FOR METABOLISM TEST - DuBois states the fundamentals in the following lines: "Many serious errors can be made in the management of the patient. In the first place one should assure perfect co-operation by explaining that the test is necessary and is for the patient's good. He must be instructed to take no food in the evening after 8 o'clock and nothing in the morning except a cup of caffeine-free coffee without milk or sugar. He should be brought to the laboratory without fatigue. His height and weight should be taken. (This can also be done after test.) He must lie quietly for at least one-half hour before test. The mouth temperature should be taken and the pulse counted at intervals until it has assumed a basal level. The atmosphere of the room should be quiet and confident and there should be as little display of apparatus as possible. Visitors must be excluded. (Conversation avoided.)"



After inhaler body is connected to inhaler the patient will breathe air only as valve to unit on inhaler body should be closed as stated in Paragraph 3.

8. HOW TO RUN THE TEST - Open the valve in the inhaler body by turning it to the left anti-clockwise as far as it will go, this valve must be turned against its seat under enough pressure to prevent leaks. Turn on chart drive motor by clock switch.

Instruct the patient to breathe regularly and uniformly relaxing as if going to sleep. As the patient absorbs the oxygen, the pen progressively rises. At the end of five or six minutes, remove the inhaler and let the patient remain quiet for a few minutes and repeat the test. Usually the second test is more uniform than the first, unless the patient has previously experienced a test.

Cut off the chart at least six inches (6 minutes) after the pen left the base (0) line. Record the temperature of the apparatus upon the chart and the reading of the barometer in millimeters. These two readings are necessary for corrections in Table A. Note also the height and weight of the patient on the chart. These are necessary for Table B. Note the age and sex of the patient on the chart; these are required in Table C. In addition, note your observation of the patient whether relaxed, anxious, co-operative or otherwise and whether you regard conditions as satisfactory—if not, repeat the test another day. Note the temperature of the patient on the chart as a fever or sub-normal temperature influences the metabolic rate and must be corrected for the final computation.

DRAW THE SLOPE OF THE OXYGEN CONSUMPTION - Place the record on a table and with a straight edge or ruler draw a straight line just under and parallel with or touching the lower points of the respiratory curves, as illustrated on sample chart, selecting that section of the record which is uniform in slope and appears to be most uniform in rate and shape, extending this line until it crosses the base line at the left and well beyond six inches (six minutes) in length to the right. This line is marked A-B. Now, beginning at the intersection of this sloped line with the base line, measure six inches to the right along the base line or count six large squares to the right for six minutes, marking the point. Perpendicular from this latter point and intersecting the sloped line the quantity of oxygen in liters absorbed in six minutes is read off. By moving the decimal point one figure to the right, we have the quantity of oxygen used per hour. In other words, at the six minute point, the distance which the sloped line is above the base line marks the quantity of oxygen used in six minutes, hence the slope of

the curve indicates the rate of oxygen absorption. Heavy lines parallel with the base line marked 1,2,3,4, indicate liters, the thin lines, one tenth of a liter or 100 cc each. Hence, in the illustration there were 2200 cc or 2.2 liters used in six minutes or the oxygen consumption was at the rate of 22 liters per hour (moving the decimal point one figure to the right, that is, multiplying by 10, since six minutes is 1/10 of an hour).

CALCULATIONS - Having determined the quantity of oxygen which the patient consumes per hour, a variety of methods may be employed to determine the per cent below or above normal. But the following is the shortest and probably the most accurate comprising three tables and involving only one multiplication and one division. The steps are as follows:

This may be done manually or automatically by using the calculator.

A. *Multiply* the volume of oxygen consumed per hour as described above by a factor taken from Table A. The product represents the number of calories of heat per hour which this quantity of oxygen produces when burned in the body together with the necessary corrections made in the same factor for temperature, barometric pressure and aqueous vapor.

B. *Divide* the calories per hour obtained in (A) by the surface area of the patient obtained from Table B. The quotient is the number of calories per hour per square meter of body surface.

C. In order to determine what per cent, the quotient from (B) is above or below normal, compare with Table C without computation.

ILLUSTRATIVE EXAMPLE-STEP (A) - Suppose the patient consumes 20 liters of oxygen per hour and the temperature of the apparatus during the test was 20 C. while the barometer stood at 690 mm. Hg. Referring to Table A, at the intersection of the temperature (20) and barometric columns (690) will be found the factor, 4.00, hence 20 x 4 = 80 calories per hour.

STEP (B) - Now, suppose the patient weighed 180 pounds and was 71 inches in height, referring to Table B at the intersection of these two rows of figures we find the patient's surface area to be two square meters. Then 80 calories per hour ÷ 2 square meters = 40 calories per square meter per hour.

STEP (C) - To find if this 40 calories per square meter per hour is greater or smaller than the normal and how much when expressed in per cent, we use Table C. Suppose the patient is a woman, aged 34 (find Female's ages 30 to 40 in the sixth perpendicular column), follow this column down to a point opposite 40 found in the first column, left margin, or (the number of calories obtained in B) and we find the number + 10. Therefore, this patient has a metabolic rate of 10 per cent above normal as indicated by the plus sign before the number. The *normal* basal metabolic rate for the patient would have been 36.5, as found in the third horizontal column of figures in Table C.

FEVER INCREASES METABOLIC RATE - Now since plus 10% is the upper limit of normal range, and minus 10% is the lower limit, this patient may be a borderline case, although within normal limits. At other times, she may show higher reading and require more tests. On the other hand, if she had a fever of 1° F. the fever which adds 7.2% per degree is probably fully responsible for making the metabolic rate border upon the abnormal. Hence, in such event the + 10% − 7.2% = 2.8%, the actual metabolic rate for this patient at this test. For subnormal temperature add 7.2% per degree. For boys and girls, use Table E instead of Table C.

TO STORE METABOLOR BETWEEN TESTS - After a basal has been completed the shut-off valve on the inhaler body should be *closed* to prevent carbon dioxide from the air coming in contact with indicator granules and changing their color before the soda lime is exhausted.

For further information on the use of basal metabolism in diagnosis, the user is referred to a book "*Basal Metabolism in Health and Disease,*" DuBois, published by Lea & Febiger. It contains references to the literature on the subject up-to-date for those who wish to learn of the development, history, etc., of basal metabolism.

PARTS LIST - For No. 186 Metabolor

Part No.	
190	Chrome Plated Steel and Porcelain Stand
191	Carrying Case with provision for inhaler, etc., black pebble leather finish
	Sodalime with indicator granules, metal container
M147	Chart Roll
M155	Ink (Oiled)
193	Breathing Tube Special Rubber Tips
820	Face Hood (Men)
821	Face Hood (Women and Children)
3216	Mouth Inhaler (Adult)
3217	Mouth Inhaler (Child Size)
M146	Nose Clamp
194	Inhaler Body with Valve
196	Composition Breathing Valves
181	Tank Yoke and Rubber Tube
183	Pen for No. 186
195	Rubber Bellows guaranteed for 5 years

SERVICE SUGGESTIONS FOR #186 WATERLESS METABOLOR

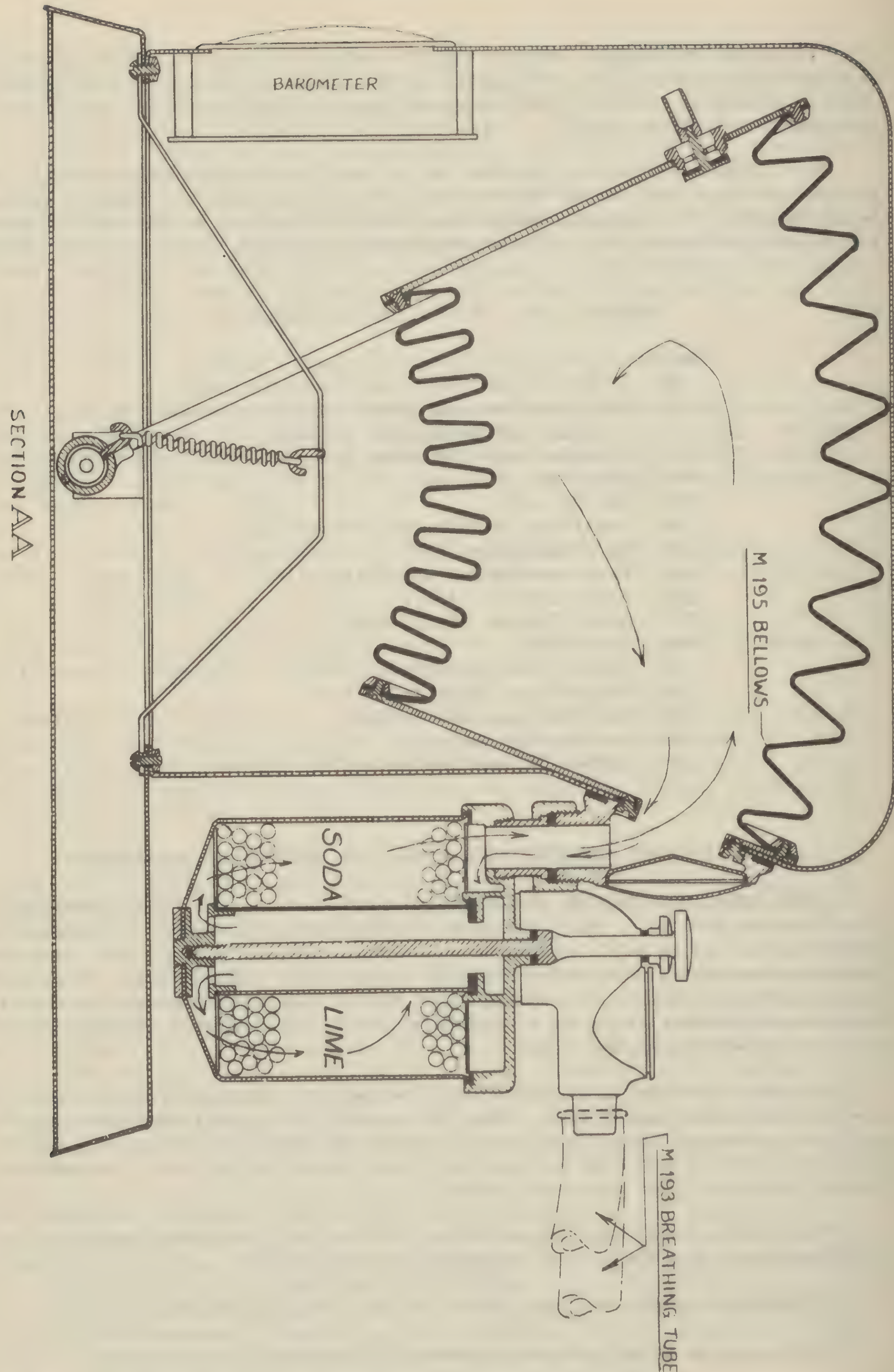
WHEN SODA LIME SHOULD BE CHANGED - Soda lime is used for removing the exhaled carbon dioxide. When the soda lime becomes exhausted, evidence of carbon dioxide accumulating will be noticed. The red granules in the glass container will turn grey when exposed to Carbon Dioxide. This gives the operator a very convenient warning that the soda lime probably needs to be changed. Exposure to air will also turn these granules grey, so as a double check, the operator should also note the patient's breathing on the chart.

If Carbon Dioxide is accumulating, the patient's breathing will become progressively deeper with each breath. That is, each of the up and down marks on the graph will get a little longer with each breath. Evidence of Carbon Dioxide will not ordinarily show until the patient has been breathing at least two minutes, (two inches horizontally on the chart paper).

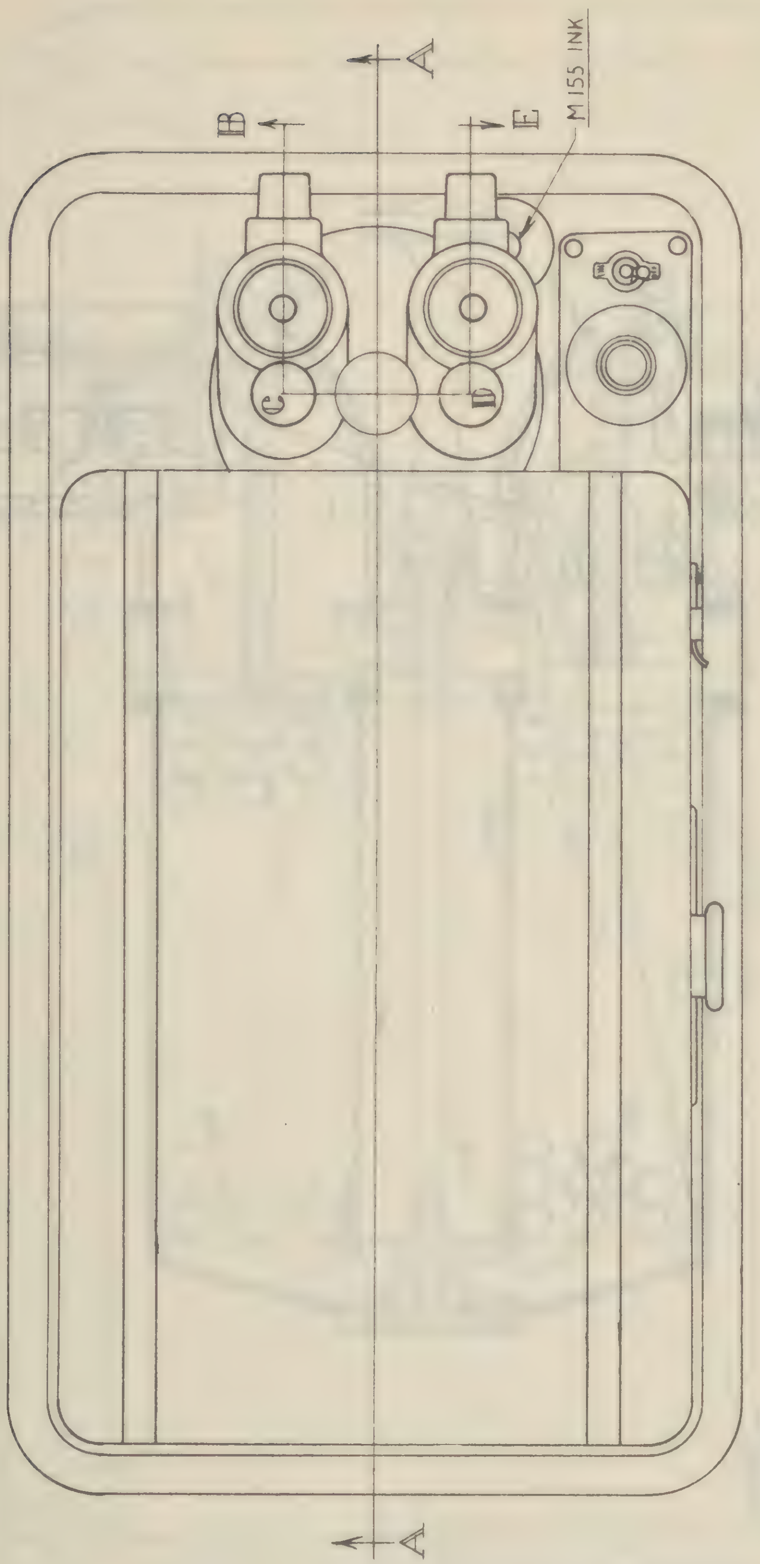
When Carbon Dioxide is accumulating, the patient notices a sensation of difficult breathing, especially at the latter part of the test.

If Carbon Dioxide has accumulated, a low test will result.

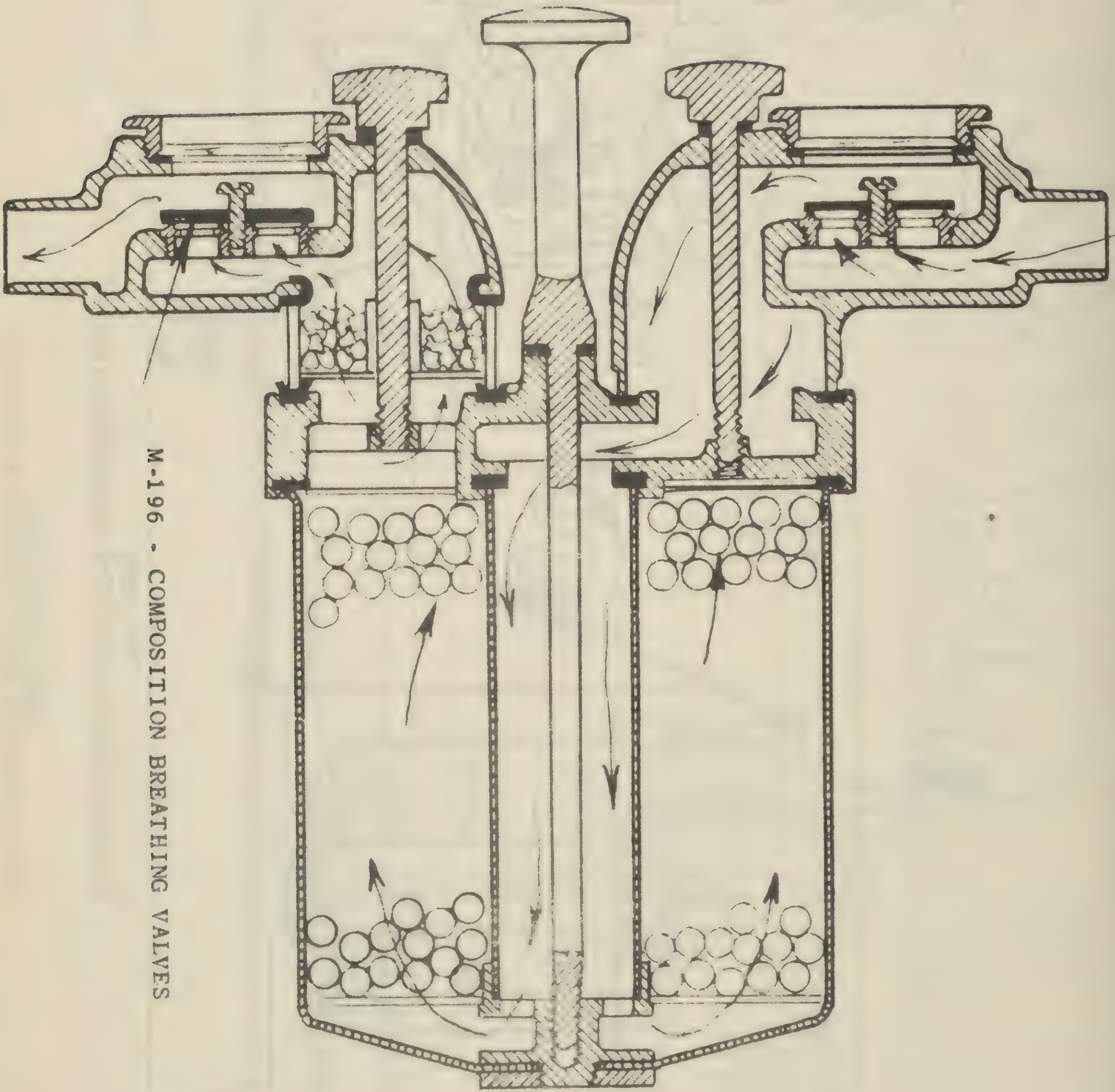
How to change Soda Lime is explained in the regular instructions.



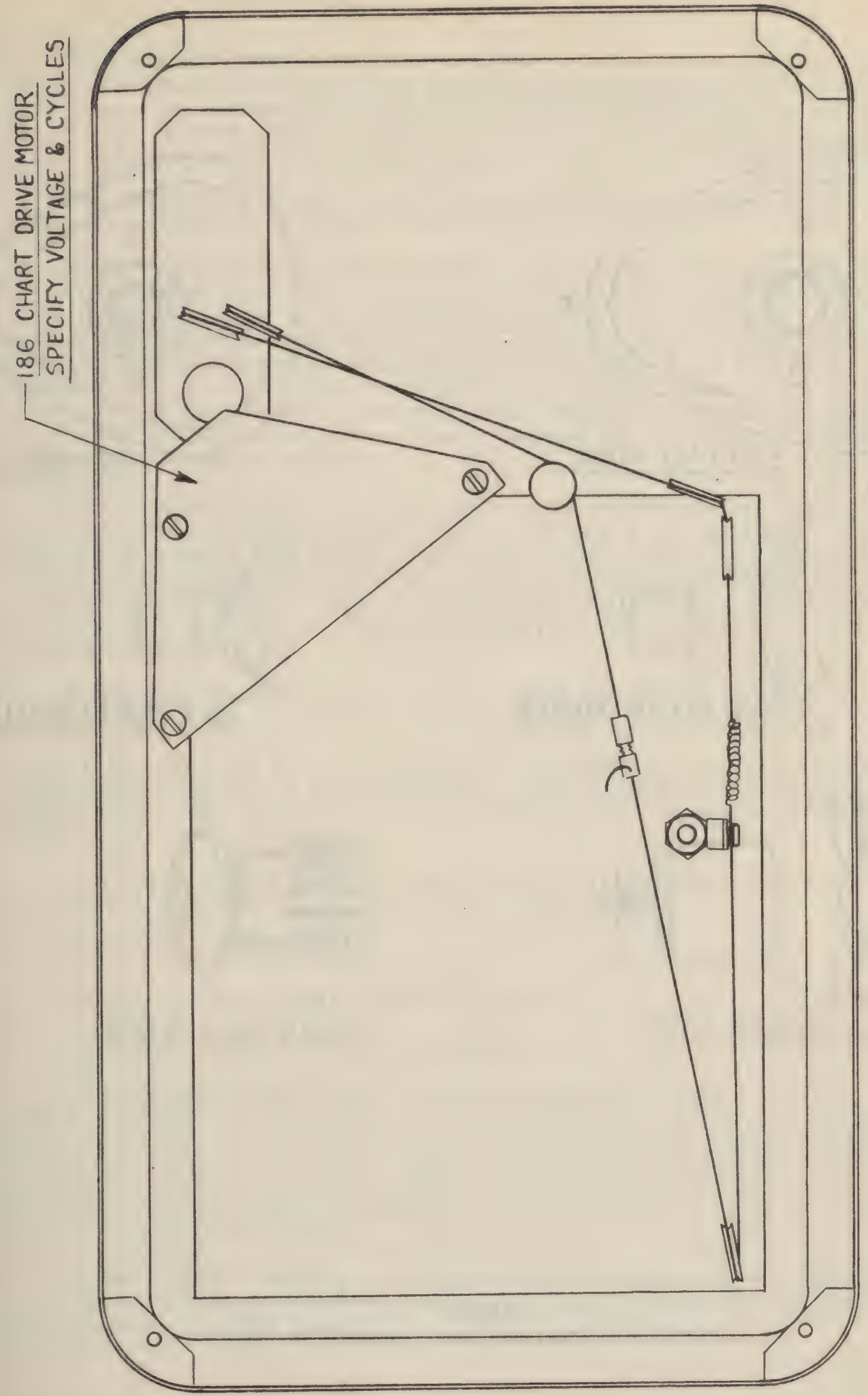
SECTIONAL VIEW
McKESSON WATERLESS TYPE METABOLOR #186



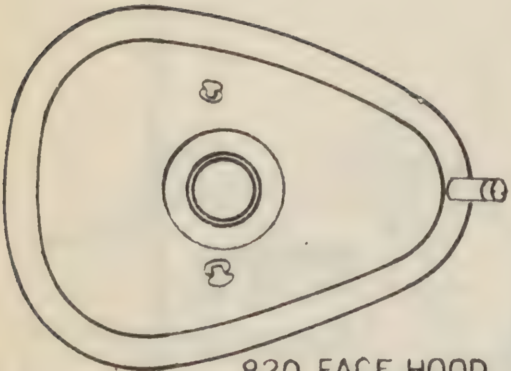
TOP VIEW
McKESSON WATERLESS TYPE METABOLOR #186



ABSORBER AND FLUTTER VALVE CHAMBERS
McKESSON WATERLESS TYPE METABOLOR #186

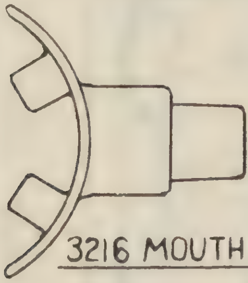


BOTTOM VIEW - STRING DIAGRAM
McKESSON WATERLESS TYPE METABOLOR #186



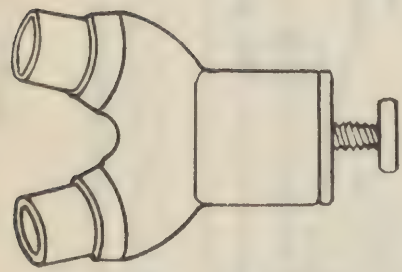
820 FACE HOOD

821 FACE HOOD

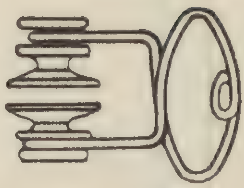


3216 MOUTH INHALER

3217 MOUTH INHALER



194 INHALER BODY



M-146 NOSE CLAMP

PARTS
McKESSON WATERLESS TYPE METABOLOR #186

SODA LIME IN INNER METAL TUBE CANISTER - Extreme care should be taken not to let even one pellet of soda lime get into the inner section of the canister. If this happens the pellets would get into the clamp rod threads and the canister would not tighten against the head gasket. If the clamp rod is difficult to screw in place, check the bottom threads in the canister to be sure they are clean.

When filling the canister, place the small indicator granule can over the inner metal tube to prevent the pellets from falling inside.

OTHER THINGS THAT CAUSE CARBON DIOXIDE TO ACCUMULATE - Examine the check valve housing over the indicator granules to be sure none of the granules are lodged under the check valve. To be sure the check valves are functioning properly, with bellows half filled with oxygen disconnect the metal inhaler body at the mask connection and while holding your hand over the end of one of the breathing tubes, try to breathe back and forth into the other breathing tube. Watch the pen during this test to be sure it goes in one direction only. Should you be able to breathe to and fro through one of the tubes, that would indicate the check valve on that side of the breathing system is defective.

To get to the check valves, remove the housing and unscrew the nut over the glass crystal with the spanner wrench that is furnished with your unit. Quite often these glass crystals will stick to the rubber washer underneath. To remove these, stick a finger nail file through one end until it strikes against the glass. You will notice the finger nail file will have to be inserted through the front end of one of the housings, while on the other housing, it will have to be inserted through the back end.

Be sure the absorber clamp rod is tightened firmly and the rubber gaskets are in position.

IF PEN STAYS AT BOTTOM - This can be caused by the spring finger being pushed above or below the PIN that holds the PEN assembly to the string. Pull the clasp spring finger up, out and over the PIN and readjust the pen assembly to the proper place.

This can be caused by the bellows being overfilled. The safety pop off will then let air in and out at the end of each exhalation.

Possibly the string is broken or is off of the top pulley.

Possibly the pen assembly should be raised.

Possibly the Inhaler "Y" is not completely open.

PEN CARRIAGE STICKS ON ROD - If the pen carriage works stiffly on the rod, both the rod and the carriage should be cleaned with a grease dissolvent such as ether or energine. Let some of the ether run down the rod through the carriage connection. Release the spring clamp from the PIN by inserting the end of your forefinger between the carriage and the clamp. This disconnects the pen carriage from the string. Now run the carriage up and down on the rod until it is free. Dry the rod thoroughly when through.

IF PEN STICKS - Sometimes an operator will overfill the pen with ink. The excess ink will then run down into the hinge. When the ink dries the pen will work stiffly and dig into the paper.

Unscrew the small thumb screw to remove pen. Clean both the stud screw and inside the pen hinge with a hand brush and water. Then replace.

IF CHART DOES NOT FEED PROPERLY - Check the absorber head to be sure it has not been pushed against the roll of paper. If it has, remove the Soda Lime clamp rod and the check valve housings, put the absorber head in the center position and tighten the large hexagon nut just below the thermometer.

Check the chart guide plate to be sure no sharp corners catch the perforations in the paper.

TO CHECK FOR LEAK - Close valve inhaler "Y" Off (screw it inward). Fill bellows about half full. Turn switch on and let pen write a line. Turn emptying knob to right with a tension until pen goes up about one fourth inch. Hold this tension for about one half minute, then release tension. The pen should return to the original line.

During the Metabolism Test, the inhaler "Y" valve should be opened completely (unscrew outward to the extreme).

WATER IN BREATHING TUBES - A considerable amount of water from the patients exhalation will collect in the exhalation breathing tube and the exhalation check valve housing. This breathing tube should be disconnected daily after using. The check valve housing should also be removed and drained. After draining, replace. *Care Should Be Exercised In The Application Of Face Mask And Oral Inhalers To The Patient As Leaks Are Very Apt To Occur At This Point.*

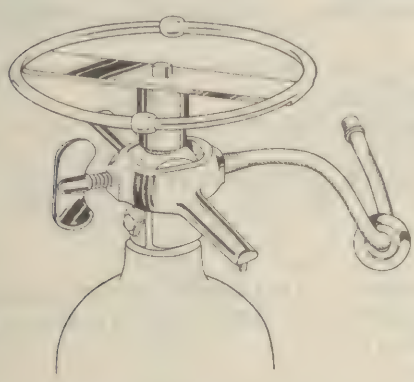
The use of Soda Lime is recommended since it is non-caustic and non-toxic, as a result it is less injurious to the equipment.

SANBORN WATERLESS BASAL METABOLISM APPARATUS

ASSEMBLING - The oxygen tank is normally shipped in its mounting within the central column of the stand. If a tank is to be installed, use the following instructions.

TO MOUNT THE OXYGEN TANK - Slip the oxygen yoke over the neck of the tank. Place it so that the projection where the tube ends inside of the yoke fits into the outlet hole of the oxygen tank. There should be a washer at this connection. Tighten the thumb-screw.

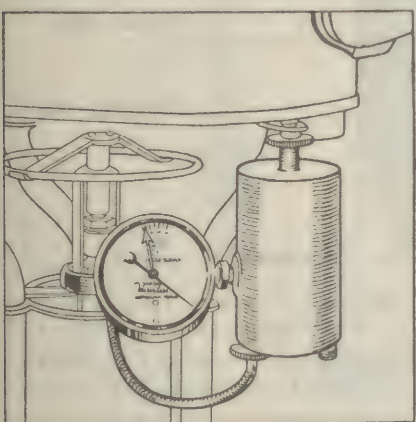
Lower the tank into the cylindrical holder of the stand. The oxygen tube should project toward the flat bracket which is attached to one of the arms of the stand. Adjust the yoke so that its pins fit into the holes in the rim of the tank holder. Add the hand-wheel.



Position of hands and head when setting tester on stand

TO MOUNT THE TESTER - Grasp the base and tilt the tester until the hooks underneath can be seen (looking from the flexible arm end). Slide both hooks on to the cross rod of the stand, as shown in illustration.

Lower the tester so the oxygen inlet in its base enters the hole in the bracket of the stand.



TO CONNECT THE PRESSURE GAUGE AND MEASURING CHAMBER - Insert the nipple at the top of the measuring chamber into the oxygen inlet on the bottom of the tester. Slide up the clamp-nut and screw it up to make a firm tight connection. There must be a small rubber washer in the inlet to seal the connection.

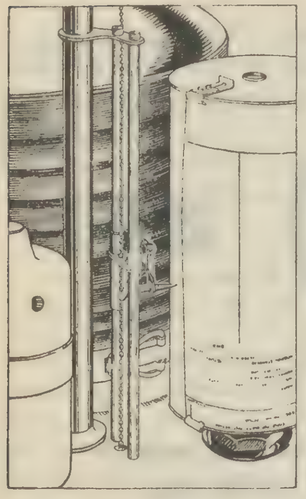
A similar connection permits the flexible oxygen tube to be connected to the bottom of the measuring chamber. See the illustration.

TO CONNECT TO POWER SUPPLY - If your power supply is 110-120 volts, 60 cycles, alternating current, connect the tester directly by plugging in the electric cord. If your supply is direct current, there should be a converter clamped to the stand. Plug the cord from the tester into the converter, and plug the cord from the converter into your

direct current supply line. When the convertor is used, control the motors by the switch on the converter, not by the switch on the tester.

PREPARATION OF THE TESTER - Before making tests, be sure the tester contains carbon dioxide (CO_2) absorbent.

TO PLACE A FRESH CHART ON THE CYLINDER - Lift chart cylinder from its spindle. Slide out chart-holding clips. While holding cylinder *upside down*, wrap a chart around it, right side up. Slide right edge ("this edge underneath") under the clips, bring left edge around and overlapping right edge; adjust chart to fit snugly on the cylinder and close the clips to hold it. Slide cylinder down on spindle, pushing it firmly over the ball friction grip until it reaches the bottom of spindle. Then turn the cylinder counter-clockwise until the writing point has just crossed the overlap of the chart, as shown in illustration.



TO ADMIT OXYGEN - Turn patient valve clockwise.

Press bellows down nearly as far as it will go.

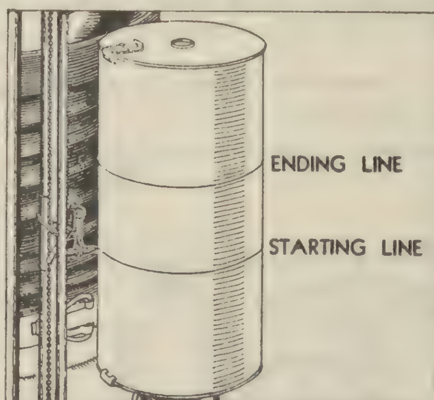
Turn patient valve counter-clockwise.

Open bellows valve.

Open oxygen tank valve a little and allow oxygen to flow *slowly* into bellows until writing point is about three inches (less at high altitudes) below top of chart.

Close bellows valve. Pressure will now build up in measuring chamber. When black hand of gauge comes directly over the red temperature hand close oxygen tank valve. If the black hand goes beyond the red one, release the excess of oxygen by opening the bellows valve slightly and briefly.

Allow the tester to stand this way for fifteen seconds or so. The black hand should remain directly over the red one. If it falls back steadily, there is a leak at one of the oxygen connections, at the bellows valve or at the safety valve (on bottom of chamber). Tighten connections or screw up safety valve adjustment a small fraction of one turn if necessary. If black hand moves a little and then remains steady it is probably affected by a change in the temperature of the oxygen inside the chamber. Admit or release a little oxygen to bring the hands together again.

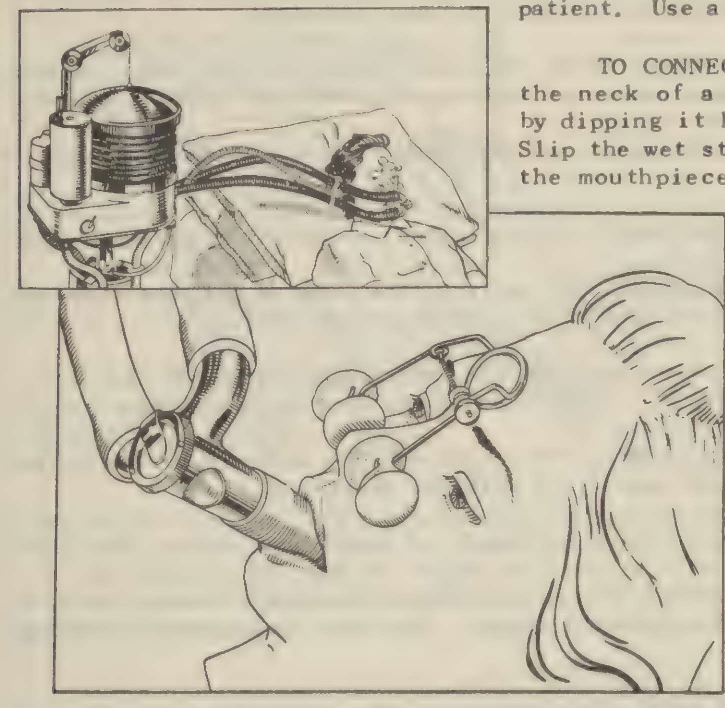


Turn cylinder counter-clockwise one full turn by hand to trace a line around the chart. Open bellows valve to admit oxygen slowly from measuring chamber to bellows. Turn cylinder again to trace a second line around the chart. Admit enough more oxygen to the bellows from oxygen tank to lower the writing point about an inch.

Before starting test see that a glass of cold water is near the tester. It will be needed to moisten the mouthpiece and to cool the leak tester.

CONNECTION OF THE PATIENT - Have the patient lie on the testing cot with head and shoulders resting on pillows at a slope of about 45 degrees.

Place the tester near the head of the cot in a position where the flexible arm and breathing tubes extend toward the patient's mouth, but where the bellows is not easily seen by a nervous or curious patient. Use a concealing screen if necessary.

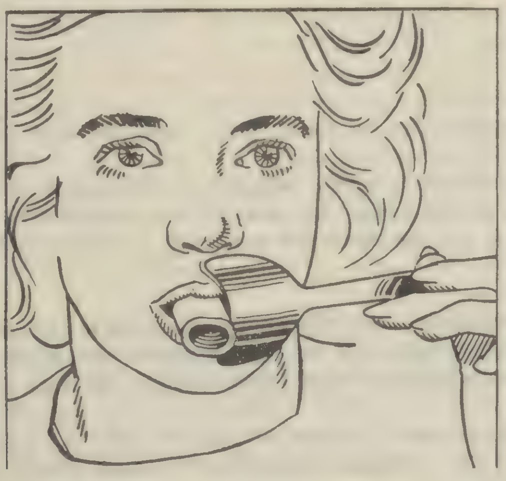


TO CONNECT THE MOUTHPIECES - Moisten the neck of a sterilized rubber mouthpiece by dipping it halfway into a glass of water. Slip the wet stem on to the projecting end of the mouthpiece connector. Place it at the correct angle to fit patient's mouth.

Adjust the mouthpiece by sliding the tubes in or out and by twisting the mouthpiece until it lies just above, and parallel to, the lips.

Have the patient set the flange of the mouthpiece between the teeth and the lips and with the two projections between the teeth. Adjust the flexible arm so that the mouthpiece does not tend to pull away from the patient's mouth. Keep the breathing tubes as straight as possible. Bent tubes interfere with free circulation.

TO ADJUST THE NOSECLIP - Turn the thumbscrew so that the sponge pads are about a finger's width apart. Fit the pads on the patient's nose, well down over the nostrils. Tighten the noseclip enough so that the pads will close the nostrils without causing the patient discomfort.



TO TEST FOR LEAKAGE - Put the leak tester in glass of cold water. When the leak tester is cool, take it out, wipe it dry, and test it by breathing on it; if the temperature is correct a fog will appear and disappear slowly. Prevent any anxiety of patient by explaining that tests for leakage are going to be made.

Hold the leak tester close under the nostrils, tilted up toward the tip of the nose, but do not allow the mirror surface to touch the skin.

Fogging on the metal mirror will show the exact source of the leak. Adjust the position of the pads and the tension of the noseclip until no fogging appears.

Hold the leak tester at each corner of the mouth, using the above method of checking leakage.

Make check tests at nose and mouth at least once during the metabolism test.

PROCEDURE FOR RUNNING THE TEST - The patient has been breathing room air through an opening in the valve of the tester. To begin the test,

START MOTORS by snapping the toggle-switch, which controls both the motor-blower and the chart motor. The red pilot light glows when switch is on.

TURN PATIENT VALVE ON (CLOCKWISE). This connects the patient to the oxygen in the bellows. The bellows rises and falls with the breathing.

TEST FOR LEAKAGE at patient's nose and mouth at least once during the test.

RUN TEST SIX TO TEN MINUTES. The record should be sufficiently long to permit easy determination of the downward slope. The chart makes one revolution in ten minutes.

The test may be continued until the tracing of the respiration reaches the line one inch from the top of the cylinder. Beyond that point reduced bellows content may interfere with the patient's ease of breathing.

TURN PATIENT VALVE OFF (COUNTER-CLOCKWISE).

STOP MOTORS.

DISCONNECT PATIENT.

REMOVE CHART FROM CYLINDER.

RECORD DATA ON CHART, including patient's name, age, sex, height, weight.

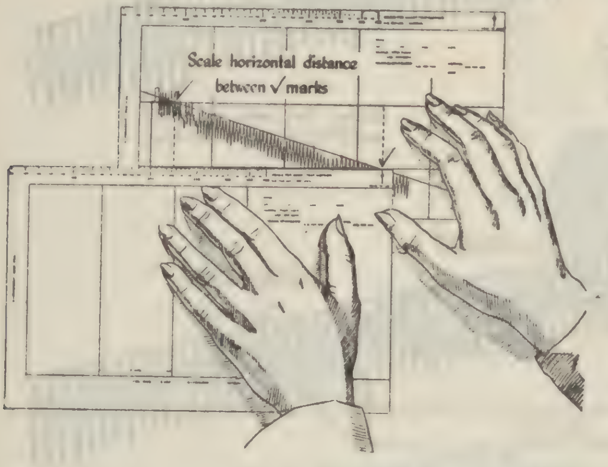
COMPUTATION - The Basal Metabolic Rate (BMR), which is the purpose of the test to measure, is expressed as the percentage by which the patient's oxygen consumption is different - plus or minus - from that of a normal person of the same weight, height, sex and age.

TO DETERMINE ACTUAL OXYGEN CONSUMPTION - Examine the respiration record on the test chart. Decide if any part of it should be disregarded because of irregularities due to restlessness of the patient, leakage or other cause.

Then lay a ruler (preferably transparent) along the peaks of the remaining record. If the peaks are uneven in height, adjust the ruler's edge until it cuts

across about half of the peaks and misses the other half. The purpose of this procedure is to obtain a slope which shows correctly the *average downward trend* of the record. Draw a line extending to the chart's edges. Some examples of respiration records, with correctly drawn slope lines are shown.

Mark the two points at which the slope line intersects the two horizontal lines which have been traced on the chart.



Measure the horizontal - not the slanting - distance between the two marked intersections.

Use the scale edge of a fresh chart. Place it along the lower horizontal line with the arrow on the right-hand intersection mark. Put a mark on the scale at the point where a vertical time-line touches it.

Slide the scale to the upper line, keeping the mark on the same time-line.

Read the Actual oxygen consumption on the scale at the left-hand intersection mark.

TO COMPUTE THE BMR BY SLIDE-RULE CALCULATOR - Set the sliding hairline of the Slide-Rule Calculator to the correct value of Actual oxygen consumption on the lower scale.

Slide the correct age-sex under the hairline.

Move the hairline over the correct height.

Slide the correct weight under the hairline.

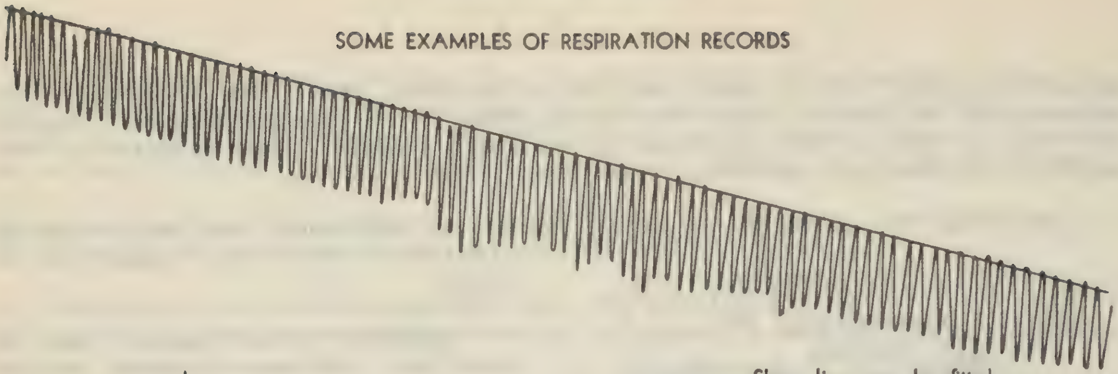
Now, over the arrow, read the BMR on the upper scale, and note whether it is plus or minus in sign.

TO COMPUTE THE BMR BY THE METABOLISM TABLES - Find a value in the Metabolism Tables (Adults' Normal Standards or Boys' and Girls' Normal Standards) corresponding to the correct height and weight. When the exact height and weight of your patient are not printed in the tables, choose a value part way between the values given of the next greater and the next smaller height and weight. Then correct this value by the appropriate Age-Sex correction, which may be found in the table for the sex of the patient under the patient's age and on the level of the uncorrected Normal. Add or subtract the correction, according to the sign against it in the table. The corrected value is the Normal standard of consumption for a person of your patient's build, age and sex.

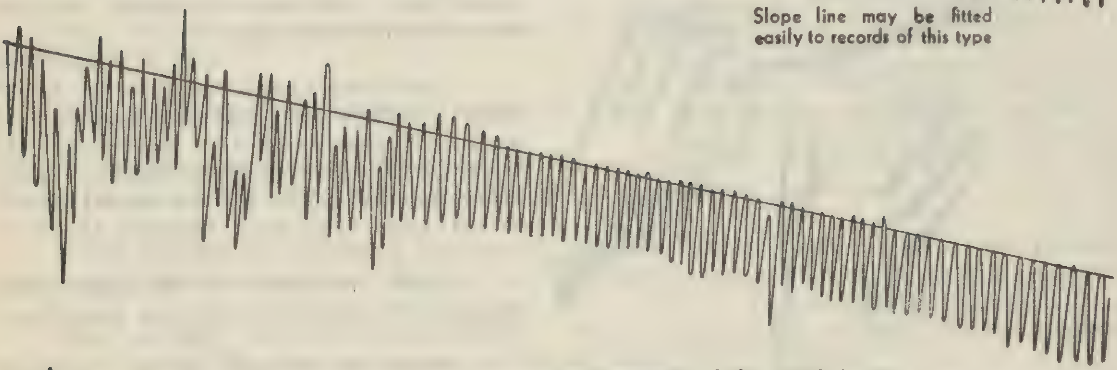
In the tables of Basal Metabolic Rate find a value which corresponds to the Actual which you have found by the chart and the Normal which you have found by the tables. Choose a value between the values printed if it corresponds more accurately to the Actual and the Normal which you have found.

EXPLANATION OF THE METABOLISM TESTER - The purpose of the tester is to measure the amount of oxygen which the patient consumes per minute.

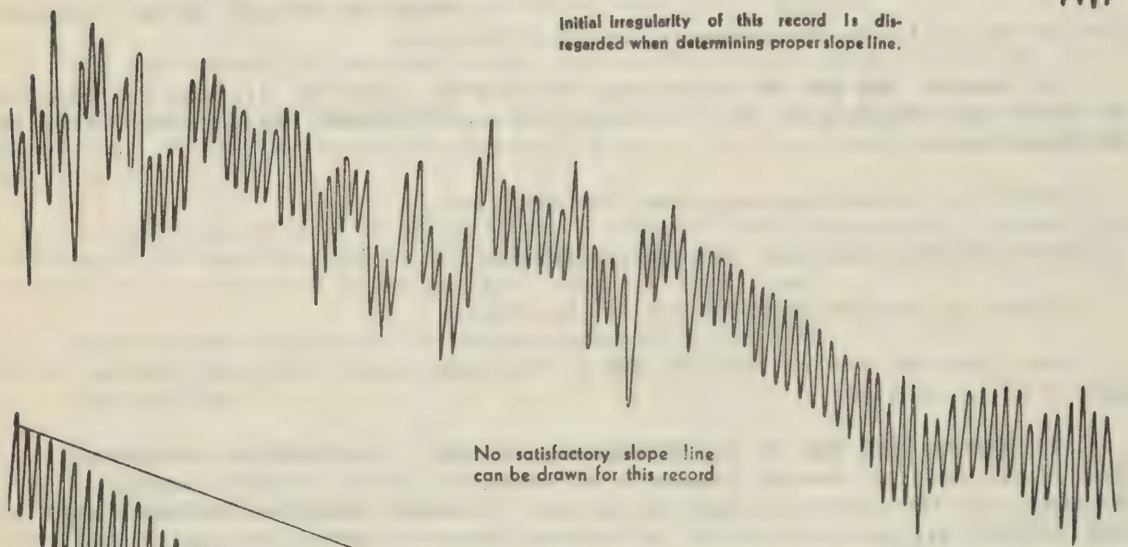
SOME EXAMPLES OF RESPIRATION RECORDS



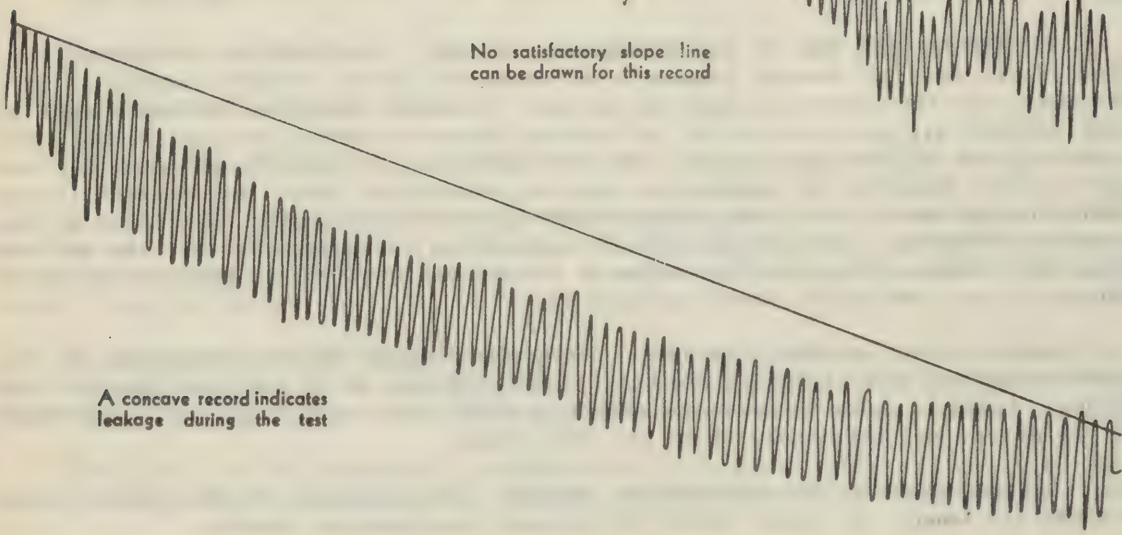
Slope line may be fitted easily to records of this type



Initial irregularity of this record is disregarded when determining proper slope line.

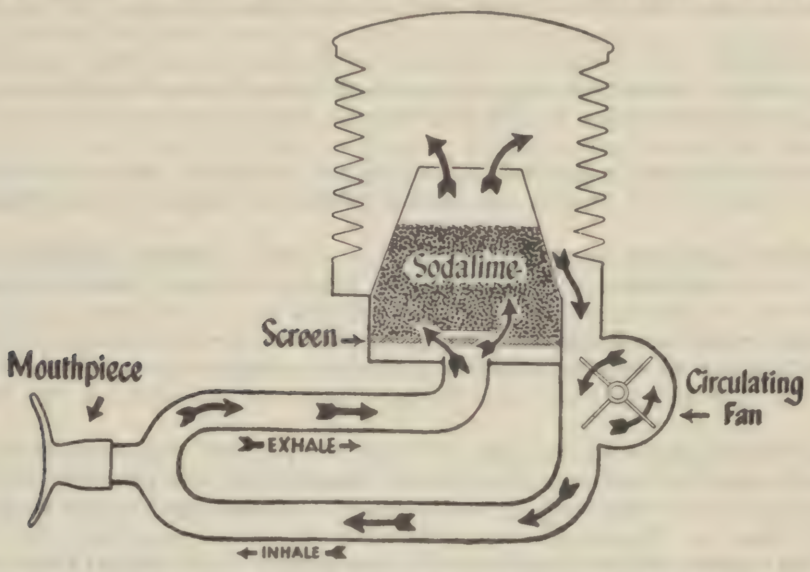


No satisfactory slope line can be drawn for this record



A concave record indicates leakage during the test

At the beginning of the test the bellows are filled with a mixture which is mostly oxygen, with some nitrogen from the air. This mixture is drawn from the bellows by the blower, pushed out through one of the breathing tubes, through the



mouthpiece connector, and back through the other breathing tube to the tester, where it passes through the absorbent and returns to the bellows, ready to be circulated again.

From this stream, as it passes the mouthpiece, the patient inhales. His lungs remove a little of the oxygen, add a little carbon dioxide, do nothing to the nitrogen, and push the mixture back into the circuit. As it passes through the absorbent the carbon dioxide is removed. The mixture may be breathed again and again, as long as it is not contaminated by carbon dioxide and there is enough oxygen remaining in it.

At the end of the test a good deal of the oxygen is gone, the nitrogen is still there, unchanged. The amount by which the bellows has become smaller is the measure of the amount of oxygen which has been consumed.

PROCEDURES FOR CHECKING AND SERVICING THE APPARATUS - To make a general check of the tester, when results are obtained which are different from those reasonably to be expected, perform one or two complete tests, including the computation, on some person whose BMR you know to be about normal and who is in a basal condition when tested.

If the resulting BMR's are close to the expected value, you will have confidence in the tester and the technic; if a difference shows up, you will know in what direction to look for an explanation. Results which are too low are likely to be due to failure to absorb carbon dioxide, either because the CO_2 absorbent itself is exhausted or because blocked circulation (or a stalled motor-blower) prevents the carbon dioxide from reaching the absorbent. Too high results come usually from outward leakage or a non-basal condition of the patient. Either type of incorrect result may be due to incorrect speed of the chart cylinder. Check one revolution of the cylinder against ten minutes on a good time-piece.

TO CHECK THE CIRCULATION - Disconnect rubber breathing tubes from the tester.

Start motors. A wisp of cotton or thread held at the breathing tube connection on the motor-blower side should show a strong current of air outward. This current indicates that the blower is running. If there is good circulation through the absorbent and bellows, the thread will indicate an inward current at the other tube.

If circulation is not shown or seems to be weak, check the condition of the CO_2 absorbent, which should not be wet, caked or packed down tightly. Any condensed moisture or caked precipitate should be removed from the tubes.

If the motor-blower is running, the top of its shaft can be seen revolving. If it becomes necessary to remove the motor-blower for repairs, see Page 40.

TO TEST FOR LEAKAGE IN THE APPARATUS * - Put a fresh chart on cylinder. Turn patient valve clockwise. Raise bellows nearly to top. Insert rubber stopper firmly in opening of mouthpiece connector. (Bellows valve should be closed. Leakage between bellows valve and oxygen tank may be tested for by opening tank valve and listening for a hiss of escaping oxygen.) Place weight of about half a pound on the bellows top (protect it from scratches). Start motors and run for ten minutes.

If the tracing ends higher on the chart cylinder then it began, outward leakage is indicated. Continue the test. Remove the breathing tubes and insert stoppers tightly in the openings of the tester. If leakage is now stopped, it was in the rubber tubes or the mouthpiece. Examine the tubes carefully for cracks; see that the patient valve closes firmly. If tubes do not fit tightly on connections, cut an inch or so off the ends to make them a better fit. Cord, wire or adhesive tape may be used temporarily to stop leaks. If leakage still continues, examine the bellows for tears and cracks, check the thermometer and blower for looseness of mountings and see that the cover-plate on the absorbent container is tight.

If the tracing ends at the level on which it began, no leakage is indicated. A supplementary test for inward leakage may be made by repeating the test with bellows unweighted and at its lowest level. If tracing ends lower than it began there is inward leakage either from the oxygen tank or from the room air. To locate the position of such a leak, repeat the procedure of closing the bellows valve, etc., as in the test with weight on bellows.

When making tests for leakage, allowance must be made for the possible warming up of the air inside of the bellows during the test. A rise of two or three degrees will expand the bellows enough to *lower* the writing point a fraction of an inch.

TEST OF CARBON DIOXIDE (CO_2) ABSORBENT - Make the test if the patients have difficulty in breathing, or if the respirations grow deeper during the test. If possible make the absorbent test soon after a metabolism test, before the absorbent has had time to recover its activity.

BY TEST STRIPS - Place two test strips in about one inch of water (preferably distilled) in an ordinary drinking glass. Shake the glass occasionally during ten minutes. The solution should have a purple tint. Remove the test strips with a glass rod. Pour the solution into a shallow enamelled pan.

Start the motors. Turn the patient valve on (clockwise). Exhale into the mouthpiece connector until bellows is well filled. Quickly turn patient valve off to retain the air in bellows.

* For leakage at patient connection, see page 32.

Lower the mouthpiece connector into the test solution. Open the patient valve and push gently down on the bellows so that the air bubbles through the solution.

If the solution turns colorless or the purple tint fades noticeably, carbon dioxide is present and the absorbent in the tester should be replaced.

If the solution retains its color, no carbon dioxide is present and the absorbent in the tester is satisfactory. However, to make sure of the efficiency of the test solution, pour it into a glass. Breathe into solution through a glass tube. If the solution is good, the color should fade noticeably or completely disappear at the end of three or four breaths.

BY LIME WATER - Half fill an ordinary drinking glass with fresh lime water (obtainable cheaply at drug stores). Pour into shallow enamelled pan.

Start the motors. Turn the patient valve on (clockwise). Exhale into the mouthpiece connector until bellows is well filled. Quickly turn patient valve off to retain the air in bellows.

Lower mouthpiece connector into the lime water. Turn patient valve clockwise and push gently down on the bellows so that the air bubbles through the lime water. Then pour the solution back into the glass.

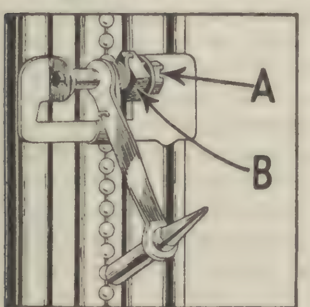
If the solution becomes cloudy or a white precipitate forms, carbon dioxide is present and the absorbent in the tester should be replaced.

If the solution remains clear, the absorbent in the tester is satisfactory. However, to make sure of the efficiency of the test solution, breathe into it through a glass tube three or four times.

If the solution turns cloudy or forms a white precipitate, the solution is satisfactory.

See instructions for replacing the absorbent.

ADJUSTMENTS-WRITING POINT PRESSURE - To change the pressure of the writing point against the chart, loosen the screw (A) at the end of the hinge, then turn the square nut (B) to increase or decrease the strength of the spring, then tighten the screw to hold the nut in its new position. The tension of the spring should be just enough to make the stylus press lightly on the chart; too much pressure makes the stylus dig into the chart's surface and adds unnecessary friction.



COUNTER-BALANCE TENSION - When correctly adjusted, the counter-balancing spring will cause the bellows top to move part way toward a central position when it is released either from its highest or its lowest position. To test the action, push the bellows down as far as it will go (with patient valve on) and release it. It should rise a little. Then pull it up to a high level and release it. It should descend several inches.

To adjust it, loosen the holding screw which is at one side of the spring adjustment (in front of tester base). Insert the blade of a fairly large screw driver in one of the slots of the spring adjustment as the holding screw becomes loose. Turn the spring adjustments clockwise to increase the pull on the beaded

chain, counter-clockwise to decrease it. Hold it in position while tightening the holding screw. Make further adjustments if necessary until a satisfactory balance is obtained.

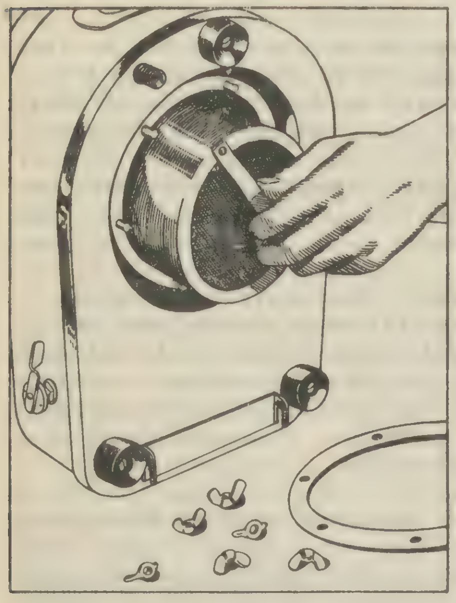
ROUTINE CARE OF TESTER - Keep the protective cover on the tester when it is not being used.

Mouthpieces should be sterilized after each use. The mouthpiece connector and the noseclip should be sterilized also, but less frequently unless contagious cases are being tested. (The noseclip pads may be kept clean for a longer period if small squares of cleansing tissue are placed between them and the patient's flesh.) Sterilization is accomplished by washing with warm water and strong soap, rinsing and immersing in boiling water for three to five minutes. Do not boil longer than necessary and keep all surfaces under the water. Most technicians prefer to sterilize the noseclip as a unit, without removing the pads. The mouthpiece connector should be taken apart (by removing the nut and the holding spring piece, then pulling out the inner shell) before sterilizing. After boiling, dry the parts carefully and put a fresh coating of Alemite cup grease or similar protective lubricant on the surfaces which are in contact.

The breathing tubes may also be sterilized occasionally by scrubbing with soap and hot water, using a stiff brush on the inside surfaces, then rinsing and boiling in the same way as the mouthpieces.

Keep the vertical rods which guide the writing point carriage clean, and see that all parts of the mechanism have proper freedom of movement. Never oil the guide rods; clean them with carbon tetrachloride or xylol. Uneven stylus action (such as faint down-strokes) is usually due to dirty guide rods.

Examine the stylus occasionally. If its point is worn unevenly, replace it. If it is loose, remove it and adjust the holding springs of the socket until the stylus is a firm push fit in its holder.



Put a few drops of oil on the top bearing of the motor-blower every few months.

ACCESSORIES AND PARTS-CARBON DIOXIDE ABSORBENT - The correct amount of absorbent for the Sanborn WATERLESS for 1942 is 1½ quarts (one quart and one pint). It should last through 60-80 tests. If it is used too long, the tests will show deeper breathing toward the end and the patient may have a feeling of suffocation. If you think that the absorbent may not be removing the carbon dioxide completely, make tests as described on previous pages. If the tests indicate that the absorbent should be replaced, proceed as follows:

TO REPLACE CARBON DIOXIDE ABSORBENT - Remove the tester from its stand and lay on its front edge, as shown in illustration. (If there is reason to believe that a considerable amount of moisture has accumulated inside the tester, first loosen but do not remove the six wing nuts, loosen the cover-plate and set the

tester level over some newspapers to drain.) Remove the wing nuts, pull off the cover-plate and pull the container straight out.

Unlock the cover of the container by grasping the knurled edge and turning counter-clockwise a short distance. Then pull up and off. Pour the old absorbent in a pail or basin. Wipe dry the container if it is moist and free the screens of any caked absorbent. Pour in 1½ quarts of carbon dioxide absorbent and replace cover, first lowering it so that the indentations in its edge slide into the grooves in the container, then turning clockwise to lock it.

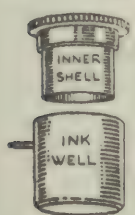
Slide the container back into the tester as far as it will go and replace the cover-plate, being sure that the rubber gaskets and the surfaces against which they press are free from particles that might prevent an air-tight seal, and that the chain inside the bellows is not caught under the edge of the container.

Screw on the six wing nuts, at first turning them only enough to hold the cover-plate lightly, then gradually tightening each one a little in rotation so that the cover-plate will be pulled up evenly against its seat. Replace the tester on the stand. Until you are familiar with the routing of changing the absorbent it would be wise to check the tester for leakage after each refilling. If a leak is found, remove and replace the container, being careful that each step is carried out correctly.

OXYGEN - The regular equipment of the tester includes an 80-gallon oxygen tank. It will be enough for from 70 to 100 average length tests. If the bellows fills more slowly than usual, the tank is probably becoming empty.

TEST CHARTS - 100 inkless charts are ordinarily supplied with the tester. The steel writing point (stylus) is for use with these charts. Paper charts (for use with capillary pen) will be supplied on request instead of the inkless charts.

CAPILLARY PEN - The capillary pen, which is regular equipment, is for use on the unwaxed paper charts, and is stored at the top of the writing point guide rods.



To use the pen, take out the shell. Drop fountain pen ink into the ink well until it is two-thirds full. Replace the inner shell and twist it a little. Press down with ball of finger on the top to force ink through the writing point. The hole through the writing point is very small. Do not allow ink to dry in it. After each day's use, rinse pen parts in hot water. A fine wire, about 0.01" diameter, may be used to clear the hole if it becomes clogged.

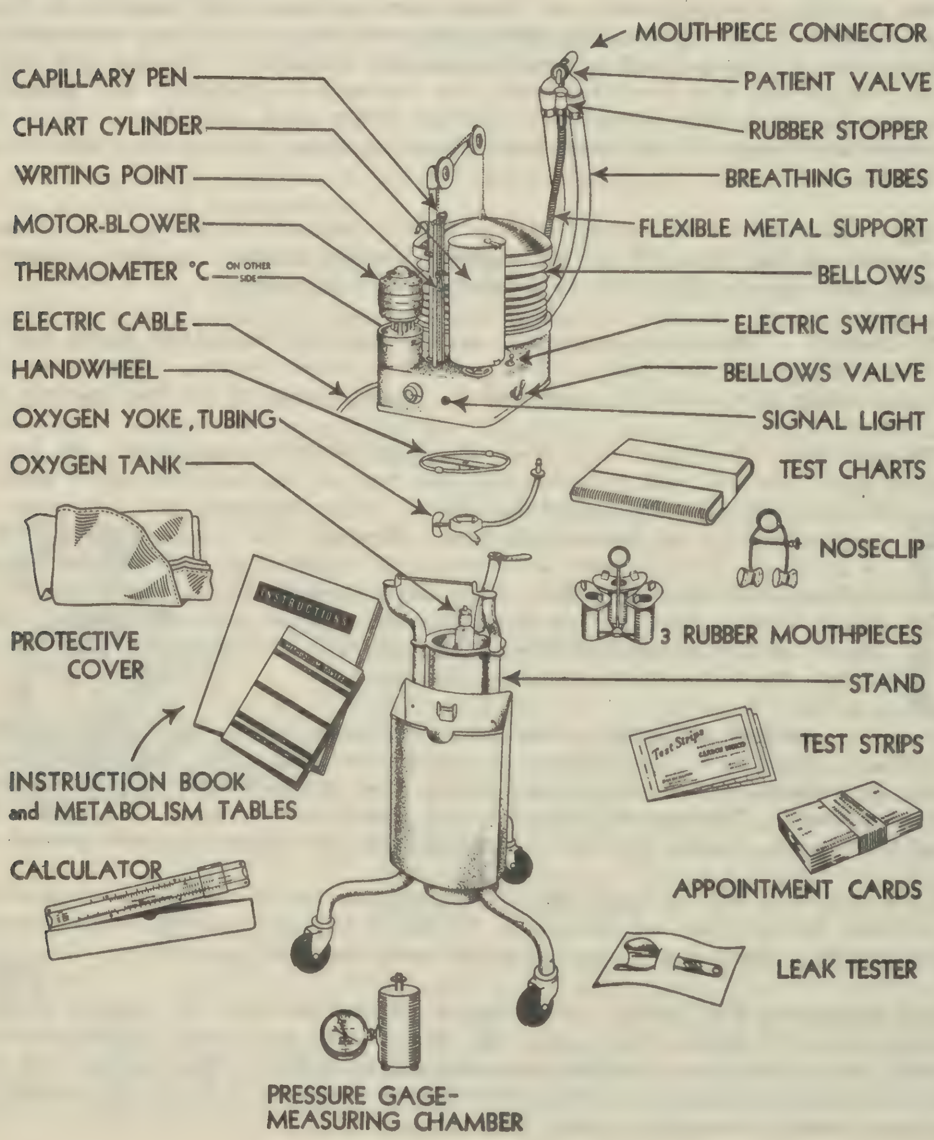
RUBBER BELLOWS - The metal bellows top is permanently attached to the rubber, forming a unit which is easily removed from the tester base and replaced. To remove, disengage beaded chain from bellows top, pry out adjustable clasp, remove band. Disconnect beaded chain inside of bellows. Lift off bellows and install new unit, using the same clamping band and replacing both beaded chains.

Before mounting the bellows see that both the inside and outside surfaces of rubber rim and the surface of the metal to which the bellows is to be clamped are clean and smooth. They may be washed with warm water if necessary.

After attaching the beaded chain inside of the bellows and before sliding the rubber down over the metal base, coat the metal with mucilage. This acts both as a lubricant to aid uniform clamping pressure and as a seal. Moistening the clamping band and the outside surface of the rubber with water will help the rubber to become adjusted evenly when the clamp is applied.

TO REMOVE THE MOTOR-BLOWER - Take off the bottom plate of the tester by removing the three holding screws from the rim. (If the plate is hard to pull off, place a small block of wood in contact with the turned-up rim and hammer the wood. This method avoids injury to the lacquer and the plating.) Then pull the motor-blower wires out of the pin jacks and remove the three nuts, washers and rubber pads (if used) which hold the blower. Do not remove the screws in the side of the blower casing; leakage may result if the seal between the blower case and its top is disturbed. When the motor-blower is being remounted, replace the washers or pads in the original positions and tighten the nuts gradually, a little at a time, in rotation, so that the blower will be drawn down evenly on the gaskets.

PARTS AND ACCESSORIES



CHAPTER IV

GAS ANESTHESIA

DEFINITION - Loss of feeling or sensation.

We are interested in anesthesia produced by the inhalation of gases since it is this equipment that you will be called upon to service.

Gas machines must be kept in proper repair as the life of the patient depends upon the exact performance of the unit. When the face mask is placed on the patient, his sustenance depends on the machine and the intelligence behind the machine, the anesthetist.

Improper functioning of a gas machine may result in:

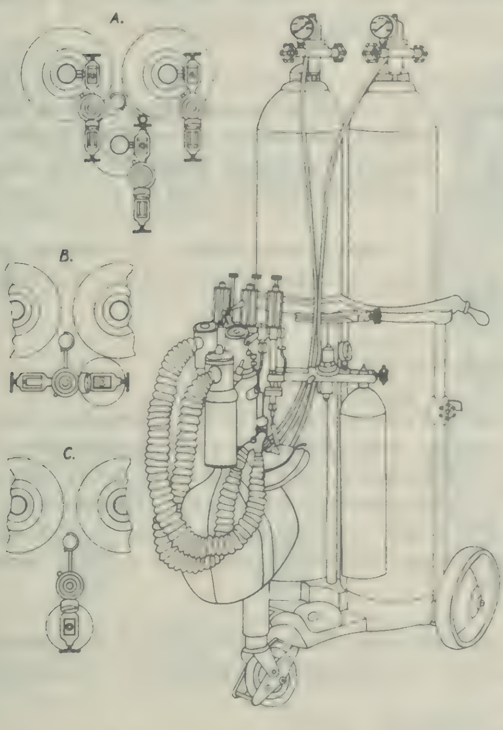
1. Difficulty for the anesthetist maintaining the proper state of anesthesia.

2. Leaks constitute an explosion hazard.

3. Loss of gas through leaks is of serious consequence where supply is limited. In many areas the Army access to anesthesia gases is very limited; therefore, none should be lost through leaks on the anesthesia apparatus.

HEIDBRINK 3-GAS KINETOMETER

The operator is especially cautioned against opening the valve of a small high pressure gas tank directly connected in the yoke of an anesthesia apparatus without first tightly closing the regulator hose shut-off valve connected in the opposite communicating yoke. Failure to observe this rule will almost invariably result in damage to the regulator or its hose and likely injury to personnel.



3-GAS CART OUTFIT
USING 2-YOKE REGULATORS

Apparatus used with compressed gases must be maintained tight at all unions of their component parts and with undamaged rubber parts to prevent gas waste. The application of strong soap suds with a shaving brush at these places and on the rubber parts which must hold pressure readily discloses leakage when the test directions given herein are followed. Simple tightening, new rubber or a rubber patch often stops it, therefore should be tried first. Where specific repairs are omitted, tightening only is indicated.

Rubber parts should be kept clean. Sterilization by boiling or autoclaving shortens the life of rubber, therefore use an aqueous sterilizing solution at room temperature. Clean metal parts with a non-inflammable cleaner.

TESTS - Leaks are best located by application of strong soap suds with a

shaving brush on all joints, unions and rubber parts. Where bubbles form there is leakage.

Start with the apparatus completely assembled. If both large and small tanks are connected to apparatus, observe caution given on first page. See that tubings, vaporizer, absorber, bag and inhaler are tightly attached. Make sure that good gaskets are on yoke nipples, all tanks are closed, tanks or yoke plugs are in all hanger yokes, all hanger yoke screws are tightened, all tank pressure yokes, gauges and flowmeters register at zero. Determine the location of leaks as follows and where found at joints or unions, try tightening first. Thereafter refer to repair instructions.

FLOWMETER HEAD

TEST NO. 1 - Close all needle valves and open one tank of each gas. All 3000-lb. tank gauges should register and flowmeter indicators should remain at zero. Should any flowmeter register, its needle valve leaks.

TEST NO. 2 - Operate all needle valves. Flowmeter floats should move up and down smoothly and "set" readily on dial indication selected.

TEST NO. 3 - Again close all needle valves and thereafter shut off all tanks. If within two minutes any 3000-lb. gauge pointer drifts downward, there is leakage of that gas in or back of the needle and emergency valves. To check for it, reopen tank, remove absorber and apply soap film over outlet of flowmeter head. If a bubble forms at head outlet, either an emergency valve leaks or there is leakage through needle valve too small in volume to cause flowmeter to register.

To determine which valve leaks, remove absorber and cover plate (5724), exposing Ports A and B. Close outlet from machine by thumb pressure and with a finger spread soap film over each exposed port. If bubble forms on Port B nearest the flowmeters, the emergency valve leaks. If a bubble forms on Port A, the needle valve leaks. After repair is made, wipe out any soap inside the ports.

To test for emergency valve diaphragm leaks, apply soap film all around under valve lever, open flowmeter needle valves and close machine outlet with the thumb. A bubble indicates a leak.

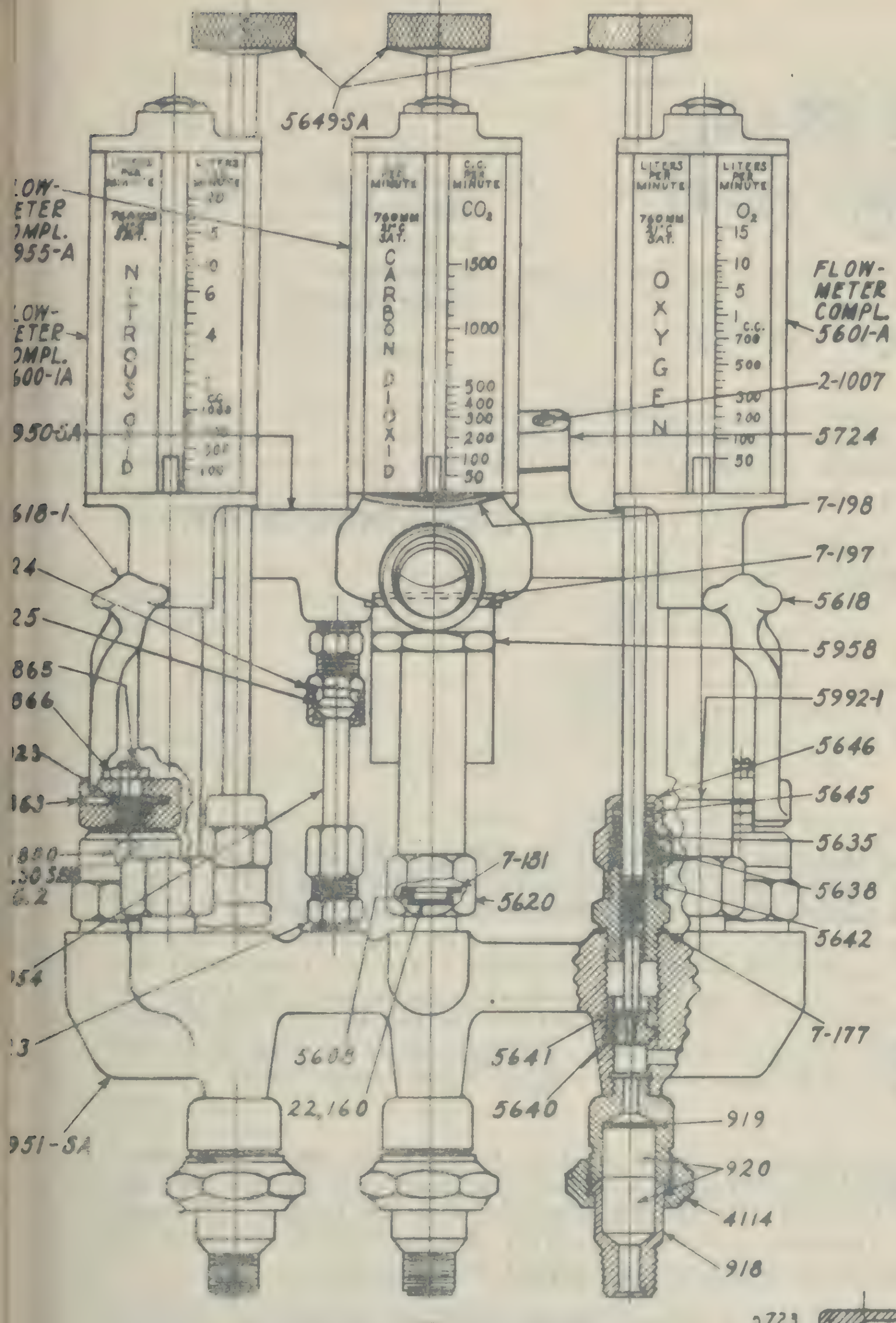
BACK OF FLOWMETER HEAD

TEST NO. 4 - Regulators, Regulator Hoses, Tank Valves__With flowmeter needle valves closed and a tank of each gas open apply soap film on tank valve stem and packing nut; on regulators around hex yoke nut (5699); all over regulator gauges; all over safety valve (lift regulator out of its support bracket); around cap nut (393); over holes in bell cap and around its rim; on regulator hose union nuts, around strainer union nut (4114), all over rubber tubings; on cast outfit around regulator union nut.

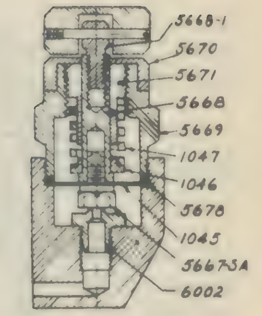
To test yoke check-valve, remove one tank and open tank in opposite communicating yoke. Apply soap film around hex yoke nut (5699) and yoke nipple (22425-SA).

IN FRONT OF FLOWMETER HEAD

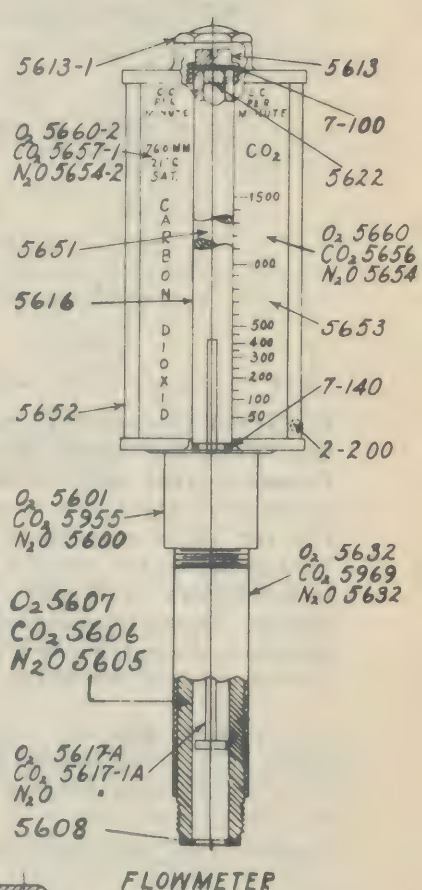
TEST NO. 5 - Absorber, Ether Vaporizer, Bag, Inhaler Tubing and Inhaler--Close inhaler shut-off valve and exhaling valve. With absorber lever (5908-1) in "down" position and central valve of vaporizer open, fill bag to slight distention.



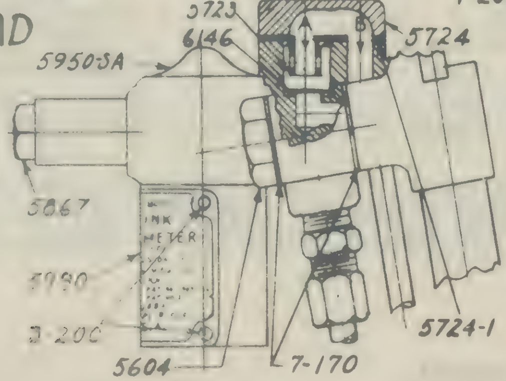
FLOWMETER HEAD
(5,950-1A)

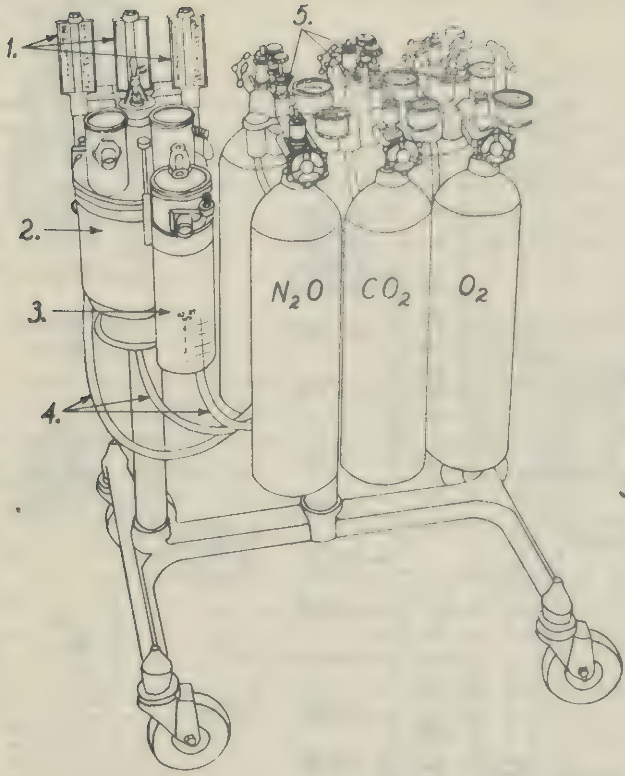


EMERGENCY VALVE



FLOWMETER





1. FLOWMETERS
2. ABSORBER
3. ETHER VAPORIZER
4. TUBINGS
5. REGULATORS

3-GAS STAND OUTFIT

If within ten minutes bag shows deflation, there is leakage. To locate same apply soap film and watch for bubbles on flowmeter needle valve packing nuts (5646); flowmeter rear and bottom connections and under levers of emergency valves; absorber union nut (4114), packing nut (5646), positive pressure limiting valve and lung inflation valve on side of expiratory valve, around bezels (5914) of inspiratory and expiratory valve covers and rim at top of soda lime can, being sure the three can brackets are tightened; all over bag, bag connection, inhaler tubings and inhaler valves; around top of vaporizer jar, packing nut (14020), dial bezel, funnel, funnel plug and union nut (14025). Also turn absorber central valve handle (10017-SA). It should operate smoothly.

Inhaler Shut-Off Valve--Disconnect valve casting from tubings and remove rubber body. Close the valve, also exhalation valve, place the thumb over one wye opening, suck on the opposite one to create vacuum and close off with the tongue. If vacuum does not hold, there is leakage. Also open inhaler shut-off valve and with two thumbs close body opening and one wye opening. Repeat vacuum test.

TEST NO. 6 - Hanger Yoke Check Valve--If the pressure in tank in opposite yoke is below 500 pounds, there may be slight leakage which is unavoidable because of the very light spring required for proper valve operation with low pressures. Such leakage will not be consequential while replacing a tank. At other times all yokes should always be occupied by a tank or yoke plug.

To test remove tank from one hanger yoke and open tank containing over 500 pounds pressure in opposite communicating yoke. Soap outlet of strainer nipple in empty yoke. If bubbles indicate *rapid* leakage, make repair. Test each yoke separately.

FLOWMETER REPAIR O_2 (5601-A), CO_2 (5955-A), N_2O (5600-1A)

NEEDLE VALVE SEAT - Unscrew stem (5649-SA) all the way out. Do not pull it through the packing which might damage it. Screw out hex stud guide (5642); unscrew seat retainer (5641) using wrench (5639). With long nose pliers remove seat (5640) and put in a new one.

STEM - If stem has picked up coppery metal on its tapered end or is otherwise damaged, put in a new one.

PACKING - Separate nut (5646) from guide (5642). Remove and examine packing discs. If three are good, add one. If four discs, put in four new ones. Screw nut partly back on guide. Screw in stem. Do not push through packing. Now tighten nut and test for leakage.

FLOAT - Remove flowmeter as follows: Unscrew stem (5649-SA) all the way out. Do not pull its threaded stem through the packing, which might damage it. Slightly loosen hex union nut (5620) at bottom of flowmeter. Screw out hex bolt (5604). If the carbon dioxide flowmeter, screw off the nut (5958) positioned beneath the top manifold. Now screw off nut (5620).

With clean and dry hands invert flowmeter and with knife or screw driver carefully remove float retention ring (5608). Carefully drop out float into the hand. Handle float gently and wipe it off with clean, lintless cloth.

Wipe out glass float tube (5616) with a pipe cleaner which afterward bend double and use to wipe out inside wall of tapered tube. Leave no lint or fragments within these tubes. Never blow the breath into the tube as moisture will be precipitated which might prevent free action of the float.

To replace the float invert flowmeter and drop float into taper tube. If float stem does not find the opening into glass tube, float will protrude. Do not press on it. Shake the flowmeter gently until the float drops to place. Replace retention ring. Should the float be at all damaged, replace with a new one.

EMERGENCY VALVE REPAIR

If either the seat or diaphragm leaks, *both* parts may well be examined.

Screw out pin (4863) and lift off lever. Remove screw (2-800) and lift off cap (5670). Do not lose ball bearing (1923). Using wrench 10-105 loosen spring cap (5671) four to five times.

Unscrew hex body (5669) containing spring cap (5671). Grasp spring guide (5668) and pull, remove screw (5668-1), spring (1047), spring seat (1046), ring (5678), diaphragms (1045) and valve (5667-SA).

Examine diaphragms for cracks and black insert of valve for imbedded particles. If thus or otherwise damaged, replace, using pliers and wrench to separate the assembly. Clean nozzle (6002) and chamber in manifold. If nozzle is damaged, remove it using wrench (10-103) and put in new one.

Assemble as follows: Place ring, spring seat (small end up) and spring over the spring guide and insert firmly against nozzle in manifold. Screw on hex body.

Screw spring cap (5671) all the way in; then back it out approximately 4/5 turn to bring countersink in line with screw hole in hex body. Back out adjustment screw (5688-1) of spring guide approximately 3/64" to line up its hole with the one in the

lever for insertion of pin (4863). Put on cap (5670) so lock screw hole points forward and lines up with preceding holes. Then drive screw (2-800) to place.

Before putting on lever, turn on gas supply and apply Tests No. 3 and No. 5. If a bubble forms lightly tap on the top of guide screw (5668-1) with light hammer. This causes the nozzle to indent the black seat material slightly and usually stops the leak

To put on lever, first back out adjustment screw (4865) approximately two full turns, then pin on lever. Now turn on the gas, again apply soap film to Port B and slowly screw in the adjustment screw until a bubble begins to form. Now back out the screw until bubble ceases to enlarge. Hold screw steady at that point and set lock nut (4866) firmly against the lever casting. Slight up and down play in lever is proper.

ETHER VAPORIZER (14000-A) REPAIR

VALVE PACKING - Remove screw (2-400) on side of vaporizer handle. Drive taper pin (14027) out through screw hole and lift off handle (14003). Don't lose friction spring (214) or plunger (14029). Hold hex packing nut (14020) with wrench and screw off lock nut (14036). Lift off ratchet disc (14035). Screw off packing nut. Lift packing cup (14023) off stem and put in one new packing disc (14024). Assemble as originally found.

CENTRAL VALVE - Repair must be made at factory.

RELEASE VALVE - Remove screw (14031) from funnel plug (14030). Drop out spring (14032) and ball (397-1). Clean all parts and put back in. If gasket on plug is damaged, put on new one.

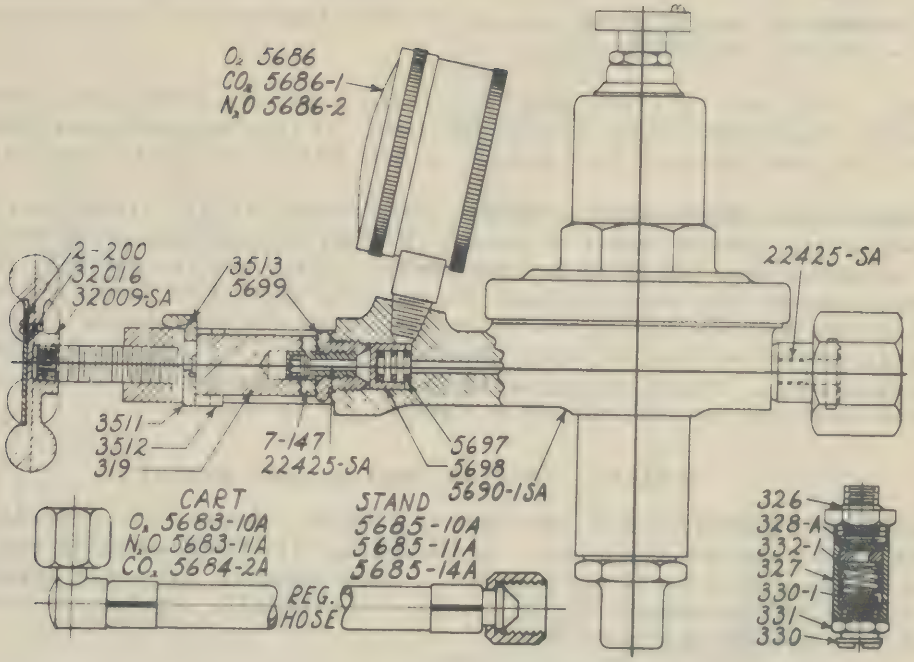
REGULATOR REPAIR - (For Cart Outfit, O_2--(5690-A), CO_2--(5690-1A), N_2O--(5690-2A) (For Stand Outfit, O_2--(5691-A), CO_2--(5691-1A), N_2O--(5691-2A).

GAUGE - If defective, put in a new one as follows: Coat stud threads with sealing graphite being careful not to get any on stud end. Screw gauge in yoke casting but avoid forcing further than necessary. The stud can, but should not, be forced in to impinge on the hanger yoke check valve. Advisable to then test check valve. Also open needle valve or direct flow lever to see that gas flows through.

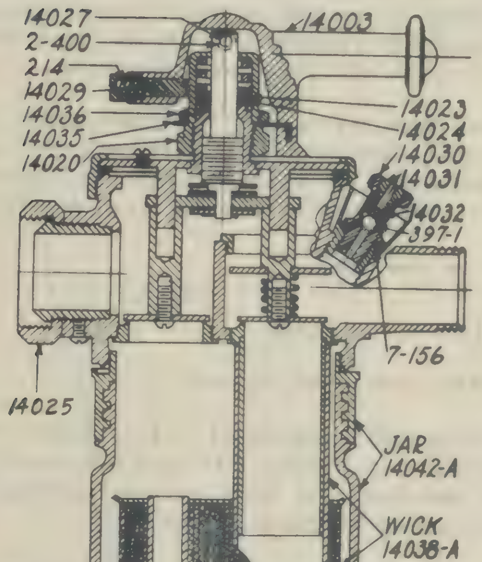
REGULATOR VALVE (391-A) - Remove hex cap nut (393), gasket (7-196), spring (304) and valve (391-A). Open tank briefly to blow out debris. Wipe out valve chamber with a clean, lintless cloth. Examine nozzle (6002-A). If damaged, remove with wrench (10-103) and put in new one. Put in new valve and replace parts. Tighten the cap nut firmly

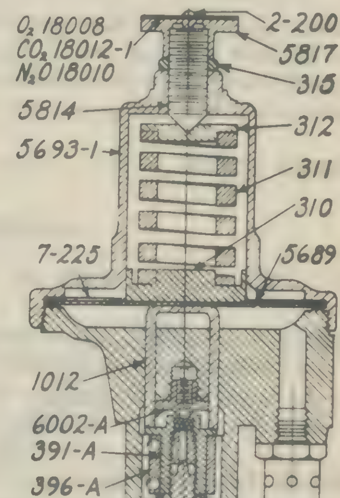
SAFETY VALVE (332-1A) - Leakage usually indicates a defective regulator valve which first should be replaced with a new one. If that does not stop the leak, screw off knurled body with the fingers. Use pliers carefully if necessary. Clean off seat of plunger (328-A) or preferably replace with new one. Do not change adjustment of screw (330). Again test. If leak persists, loosen lock nut (331), tighten adjustment screw and "set" nut.

DIAPHRAGM (5689) - Remove regulator from its bracket. Tighten down bell cap (5693-1) with wrench (1-425). If this does not suffice put in new diaphragm as follows: Screw off bell cap. Remove bell cap and loose parts and diaphragm. Paint outer rim surface of new diaphragm with sealing graphite where it contacts its seat



REGULATOR & TUBING





ETHER VAPORIZER
(14,000-A)

on body (5690-1-SA). (Use no substitute lubricant containing oil which could ignite in the presence of oxygen under pressure.) Put diaphragm and loose parts in place, and screw bell-cap on firmly.

HOSE - For cart O_2 (5683-10A), N_2O (5683-11A), CO_2 (5684-2A). For Stand O_2 (5685-10A), N_2O (5685-11A), CO_2 (5685-14A). If tightening strainer union and end nuts fails to stop leaks at hose unions, or the rubber hose leaks, put in a new hose.

HANGER YOKE CHECK VALVE - Remove lock screw (3513), stabilizer parts and handwheel screw. Insert handle of wrench (10-104) through yoke screw hole to engage socket of wrench when fitted to hex nut (5699). Screw out the hex nut. If difficult to loosen, remove lead gasket, place the end of a short 3/8" brass rod against the gasket surface and tap lightly with a hammer. Open the tank in the opposite hanger yoke sufficiently to blow out valve plunger (5698). Then open tank wider to flush out valve chamber. Clean off valve surface, or if damaged put in new valve. Inspect and clean seat on hex nut and if damaged put in new one.

INHALER, INHALER TUBING, BAG REPAIR

INHALER COMBINATION AIR AND SHUT-OFF VALVE - Screw out perforated hex nut (5382-SA) to remove valve assembly. Screw off nut (5-1004) and valve head (5385-SA). Observe how remaining parts are assembled, then separate and clean thoroughly. If valve seat (5386) is damaged put in new one. If opposite seat on the valve head is damaged, put in whole new valve head.

To assemble first place spring (5389) and washers (5389-1) on stem (5384-SA) and insert in knob (5381). Then put perforated hex nut on stem so rollers are at bottom of slots in knob. Hold thus and assemble remaining parts on stem only far enough to permit threads of nut (5-1004) to catch well without tightening.

Holding perforated hex nut firmly, turn knob left about 7/8 turn--until rollers drop into slight depression. Now screw down valve head to *lightly* contact seat of hex nut and thus close air valve. Then turn knob to extreme right to open valve, screw down valve head approximately 3/4 turn and tighten to place with nut (5-1004).

INHALER TUBING, BAG - Patch or put on new one.

ABSORBER (10,150-A) REPAIR

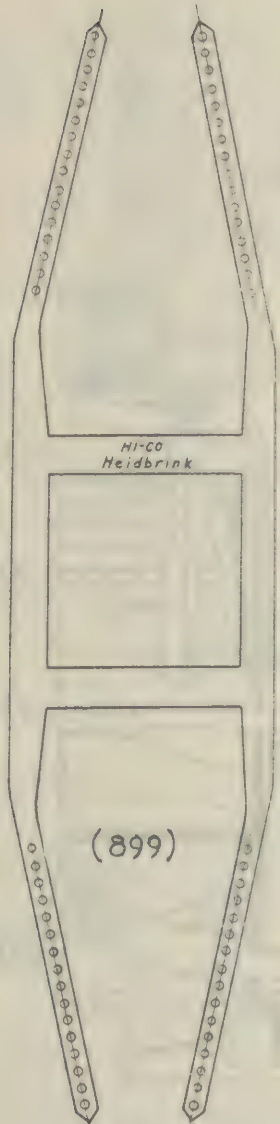
NOTE - Half-cover (10048-SA) for canister not shown in cuts.

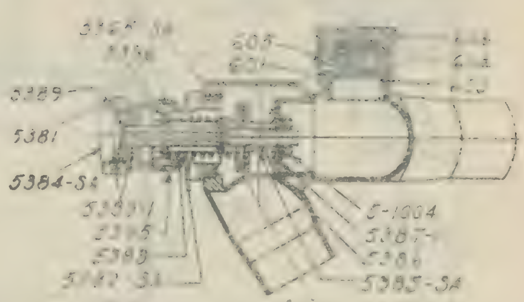
CENTRAL VALVE PACKING - Remove screw (2-605) and handle (10017-SA). Remove packing nut (5646), spring (5645) and packing cup (5635). If packing discs (5638) appear to be good and there are three, add one disc. If four, put in four new discs. Assemble all parts being careful that discs go inside packing cup.

CENTRAL VALVE - Remove absorber, detach ether vaporizer and tubings. Remove screw (2-605), handle (10017-SA), packing nut (5646) together with spring (5645), packing cup (5635) and packing discs (5638). Slip off pointer (10010-SA) and remove dial (10019). With spanner wrench (10-114) remove valve cap (10105). Remove absorber can (10120-SA). Remove nut (5-1403). Spring (5939) will drop out. Pull off valve key (10006-SA), clean and coat outer surface with vaseline.

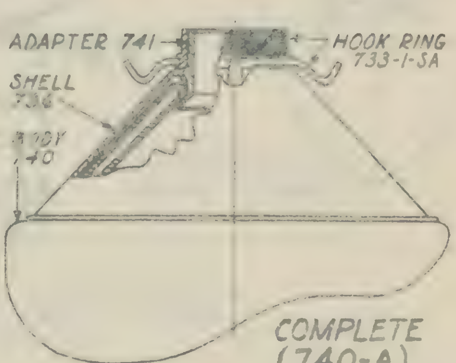
Grasp top end of stem of valve (10002-SA) and pull valve out. Clean outside surface and walls of valve chamber and coat outside surface of valve with vaseline and put valve back in.

COMPLETE (730-A)



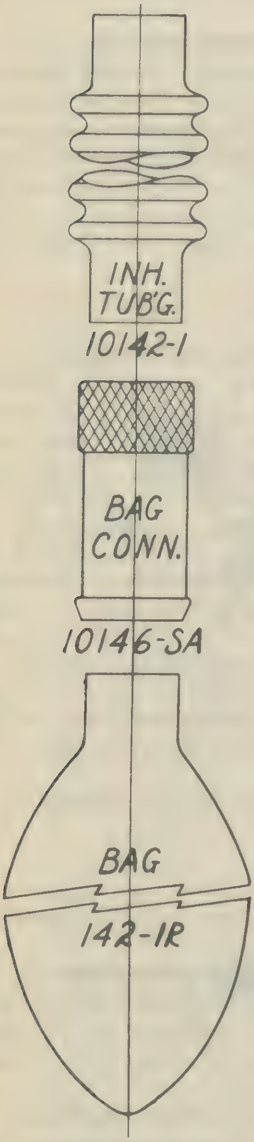


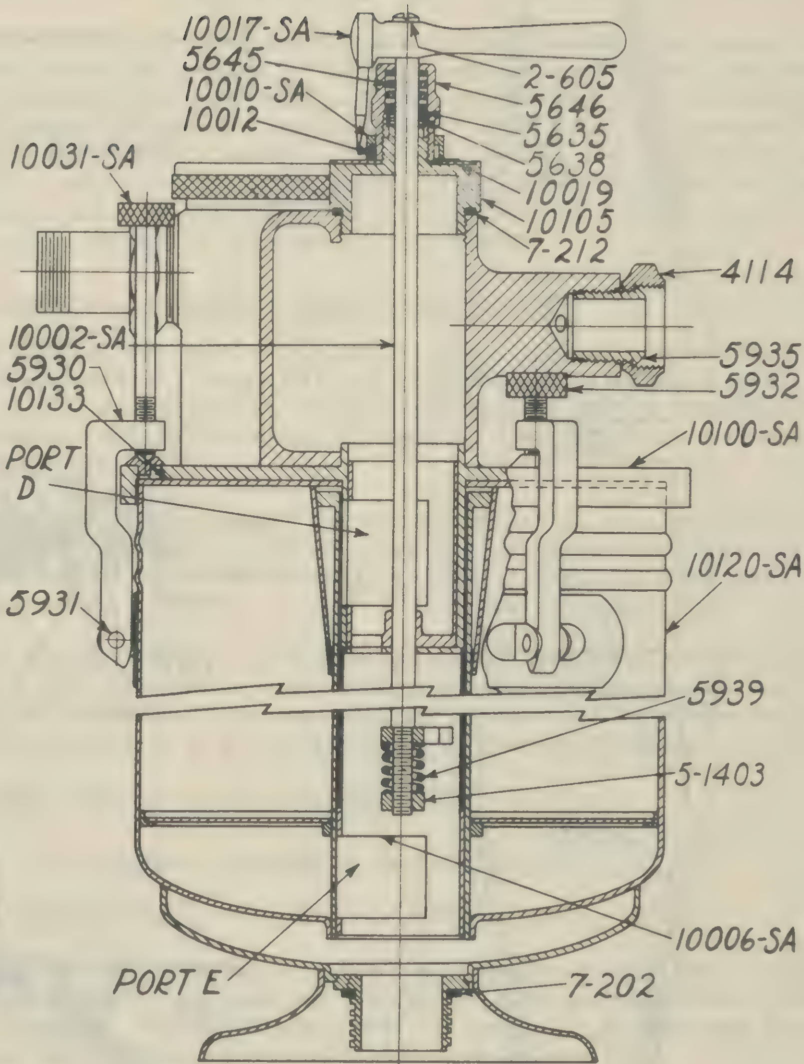
COMPLETE (5,365-A)



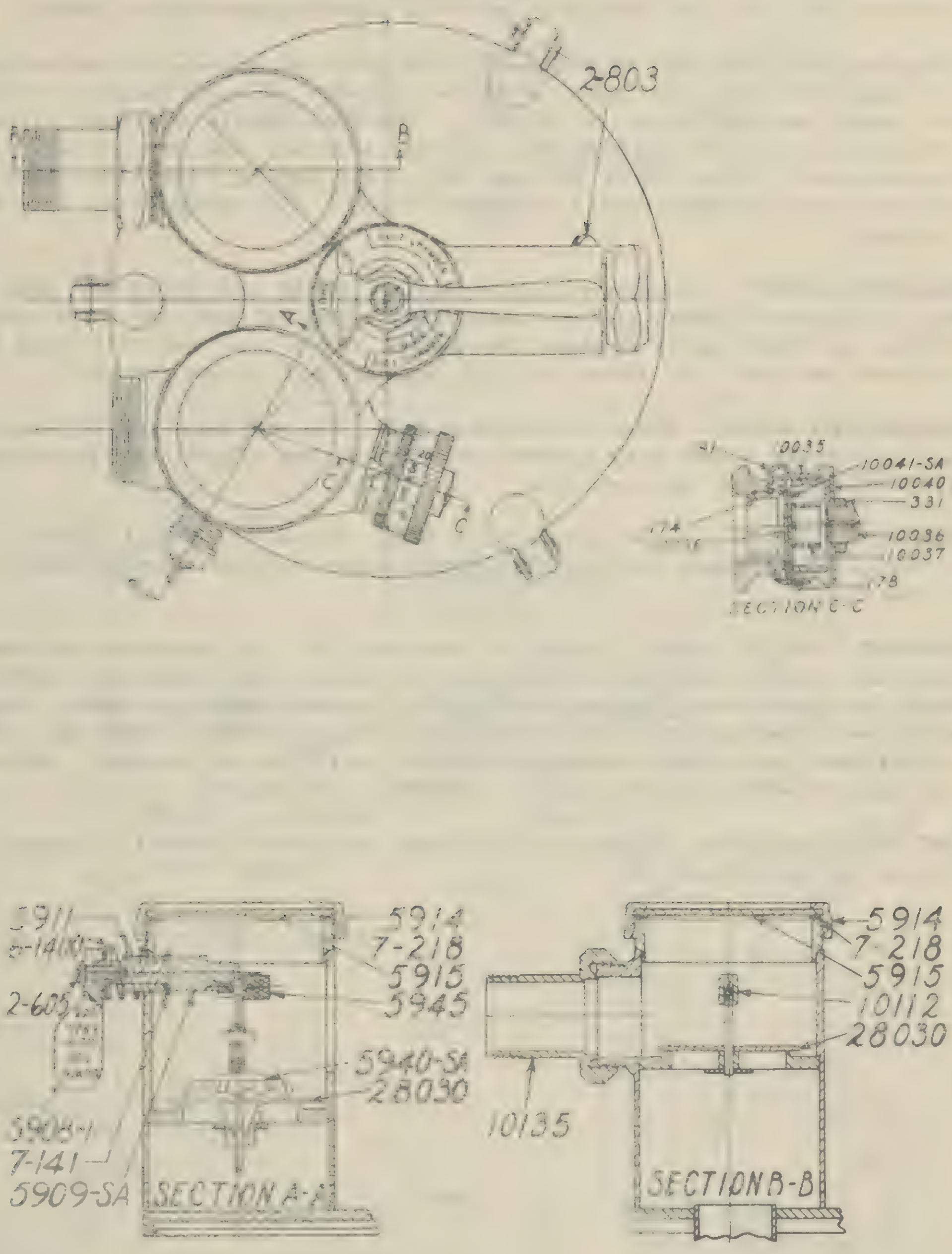
INHALER AND RETAINER

COMPLETE
(740-A)





ABSORBER
(10,150-A)



ABSORBER-TOP AND VALVES

Now screw on cap (10105) tightly. Put on dial with "Shut" to front and centrally located between inspiration and expiration valves. Put packing washers (5638) in cup (5635), invert it (gaskets down) and place with spring (5645) on valve stem. Holding dial in above described position tightly screw on nut (5646).

Using handle (10017-SA) as a wrench, turn stem of valve until bottom port of valve is open (the two side ports will be closed). Put on handle so pointers straddle "shut" and put in screw (2-605). Now turn handle and open either side port. Put lower valve key (10006-SA) on valve stem so side port of key lines up with the open port. (See Ports "D" and "E"). Put spring (5939) on lower end of stem, screw on nut (5-1403) until it binds snugly. Put on can with long bracket screw in front.

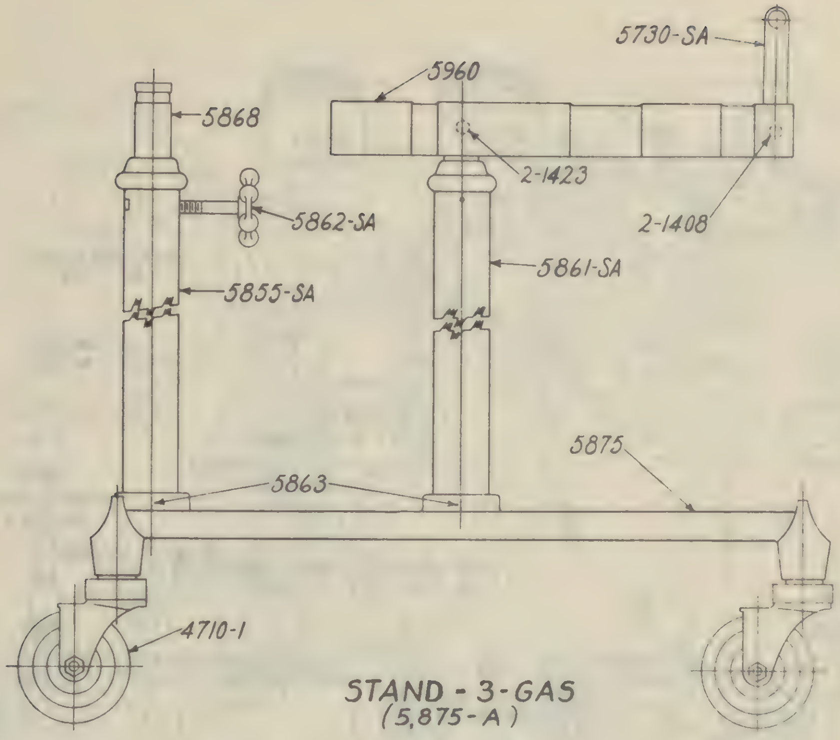
CANISTER GASKET - Loosen canister screws (5932 and 10031-SA) and remove canister. If gasket (10133) appears undamaged, clean off any corrosion around the edge of the can which seals against the gasket and put on can with long bracket screw in front and test. If there is still leakage, put in new gasket.

INSPIRATORY VALVE - Refer to Section A-A. Remove bezel (5914) and window (5915). To release valve disc (28040) remove knurled screw (5945) and push-rod assembly (5940-SA). Put in a new disc.

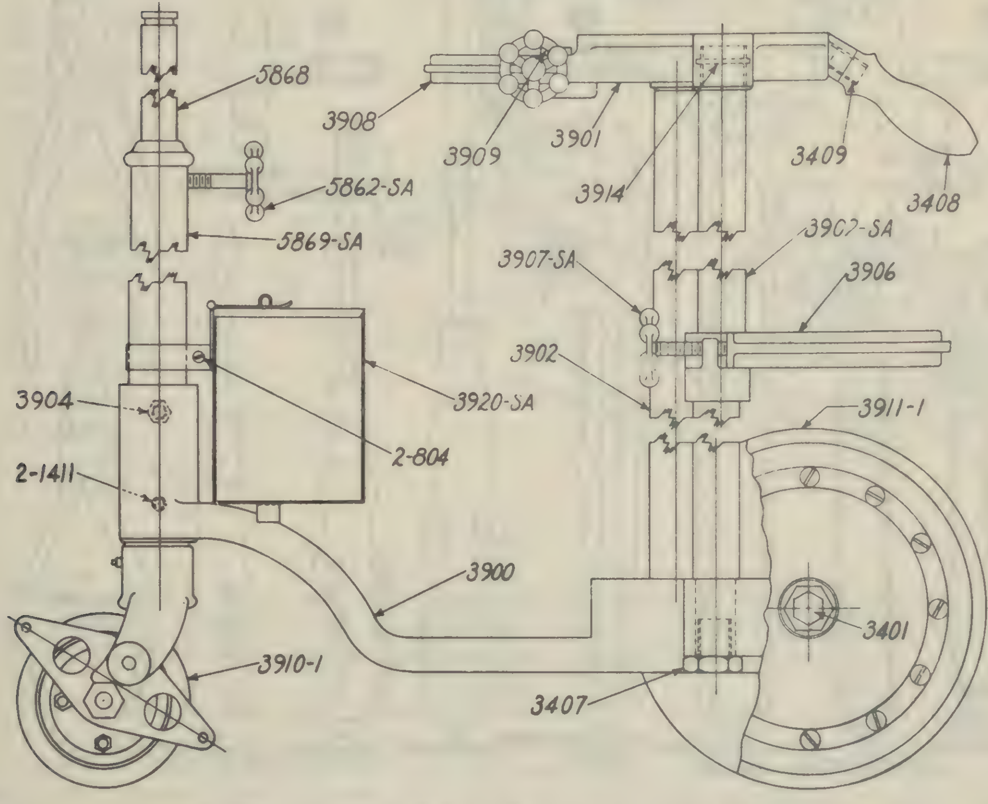
EXPIRATORY VALVE - Refer to Section B-B. Screw off bezel (5914), remove window (5915). To release valve disc (28030) screw off the knurled knob (10112). Put in a new disc.

PRESSURE LIMITING VALVE - Refer to Section C-C. If adequate equipment for measuring gas pressure not available, best to loosen lock screw and tighten down cap (10035) to limit, thus closing the valve; or replace with new valve. Repair is made as follows: Remove screw (178) and screw off cap (10035). Drop out and clean spring (10037) and valve disc assembly (10041-SA) will then be exposed. Also clean inside of cap and perforated body (174). Assemble and Adjust.

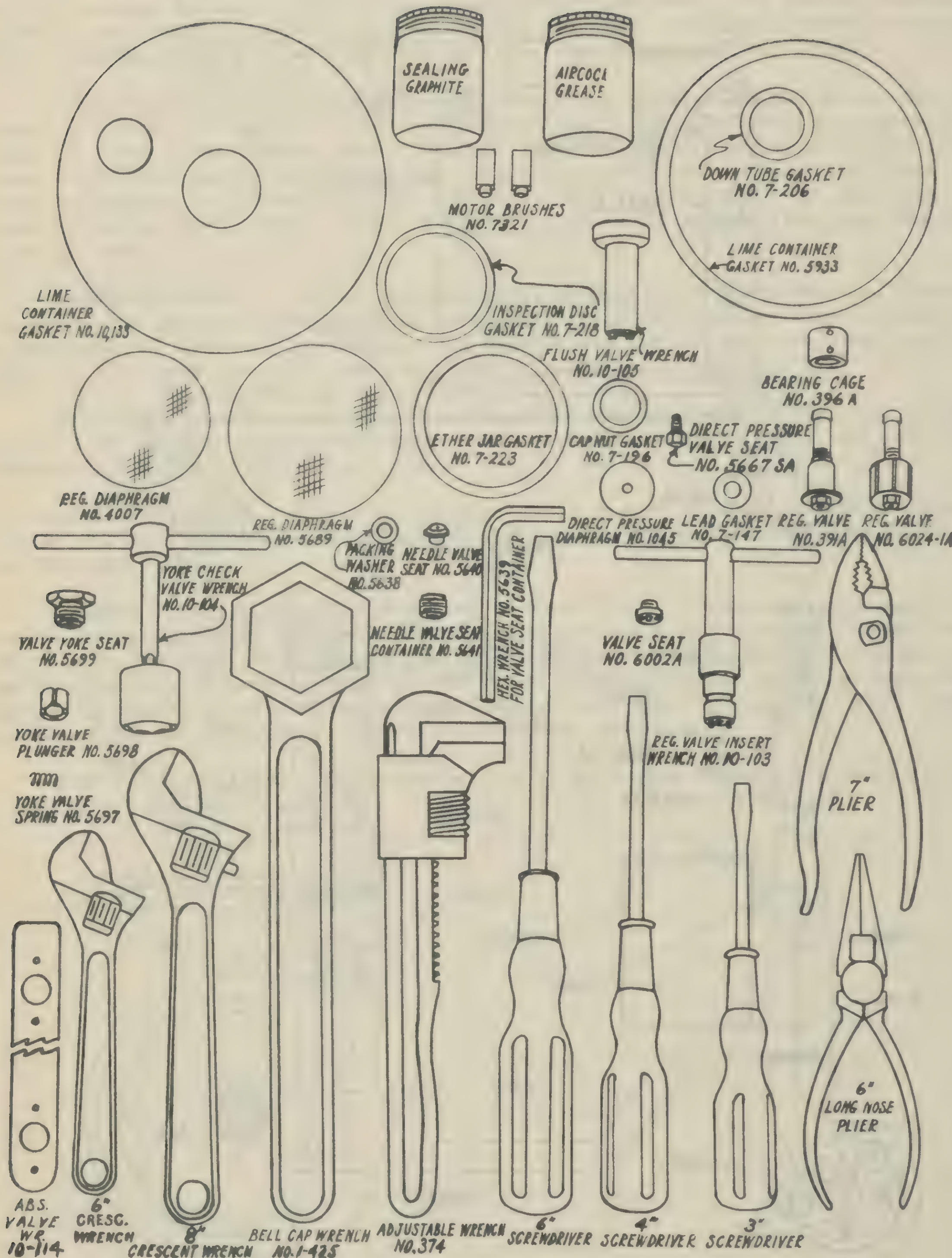
LUNG INFLATION VALVE - Remove screw (2-605) and handle (5908-1), stretch spring slightly and put parts back on.



STAND - 3 - GAS
(5,875 - A)

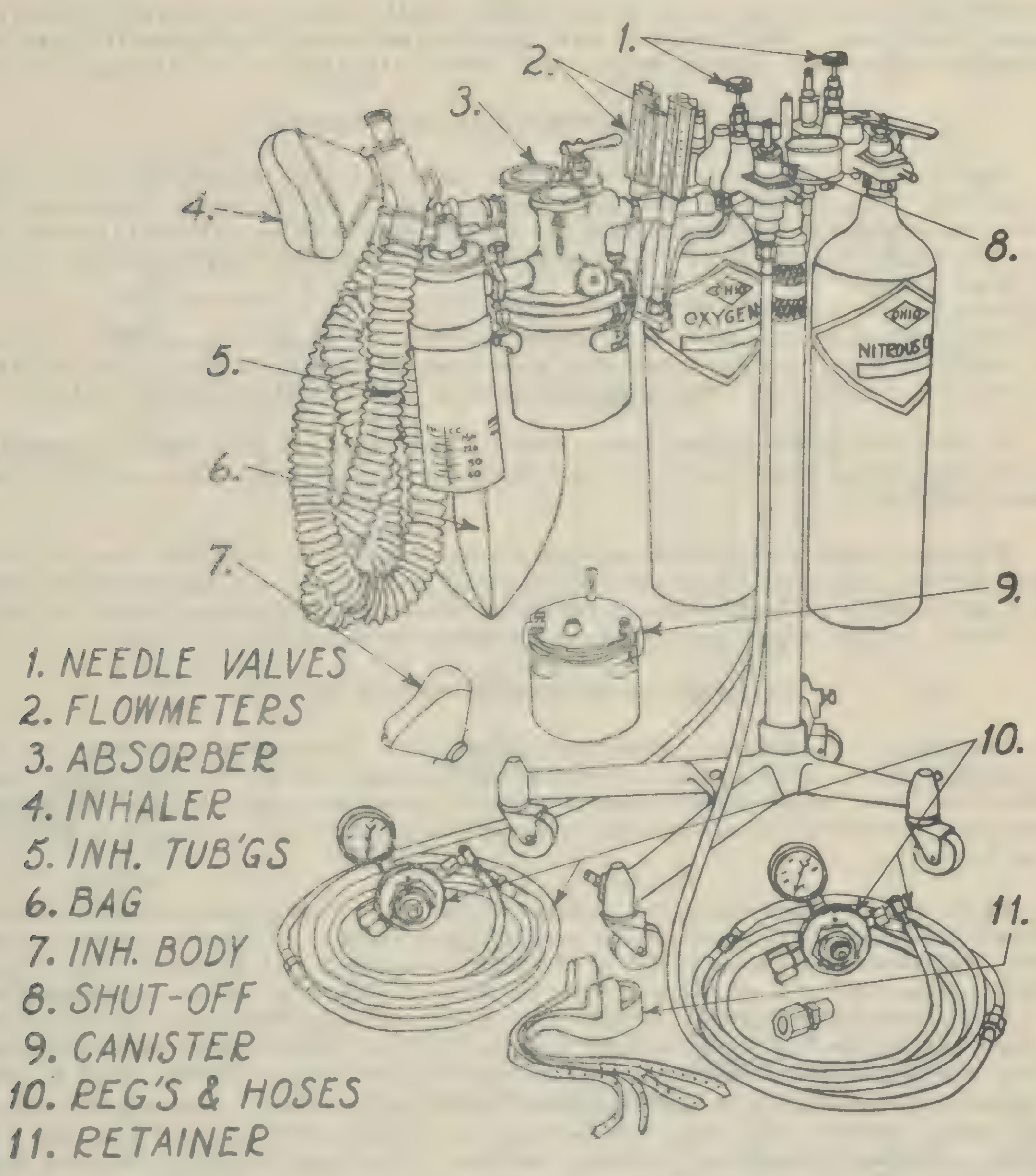


CART - 3 - GAS
(3900-A)



TOOLS, GASKETS, ETC.

HEIDBRINK MILITARY MODEL #685



TESTS

Start with the apparatus completely assembled and with the regulators attached to large tanks or with a small tank in each yoke. If only one small tank of each gas available, put yoke plug in opposite intercommunicating yoke.

If both large and small tanks are connected to apparatus, observe caution given. See that tubings, vaporizer, absorber, bag and inhaler are tightly attached. Make sure that (1) good gaskets are in place, (2) all tanks are closed, (3) all hanger yoke screws are tightened, (4) all tank pressure gauges and flowmeters register at zero. Determine the location of leaks as follows and where found at joints or unions, try tightening first. Thereafter refer to repair instructions.

GAS ANESTHESIA

OPERATIVE HEAD

TEST NO. 1 - Close both needle valves and open one tank of each gas. If a flowmeter registers, its valve leaks. Turn needle valves to operate flowmeter floats up and down. They should operate smoothly and permit being readily "set" at calibration selected. Needle valves must close off tightly for the next tests.

BACK OF FLOWMETER NEEDLE VALVES

TEST NO. 2 - Close needle valves, then open and immediately close one tank of each gas. Observe the calibration at which each 3,000-lb. gauge registers. If within two minutes either gauge pointer drifts downward and flowmeter does not register, there is leakage of that gas back of the flowmeter needle valve. Check for it as follows:

Apply soap film and watch for bubbles (1) around hex yoke nut (5699); (2) all over 3,000-lb. gauge and its stud--we cannot repair gauges--if defective, replace with new one; (3) on tank valve stems and packing nuts--tighten nuts if needed.

To test yoke check valves remove tank in one yoke and open tank in opposite communicating yoke. Apply soap film and watch for bubbles around hex nut (5699) and nipple (22425-SA).

Also apply soap film on stem and packing nut (22648) of regulator hose shut-off valves (909-A), all over hoses and around their several union nuts; all over regulator safety valve (332-3A), around regulator cap nut (25379), over holes in bell-cap (19142) and all around its rim where it screws on regulator body (15825).

IN FRONT OF FLOWMETER NEEDLE VALVES

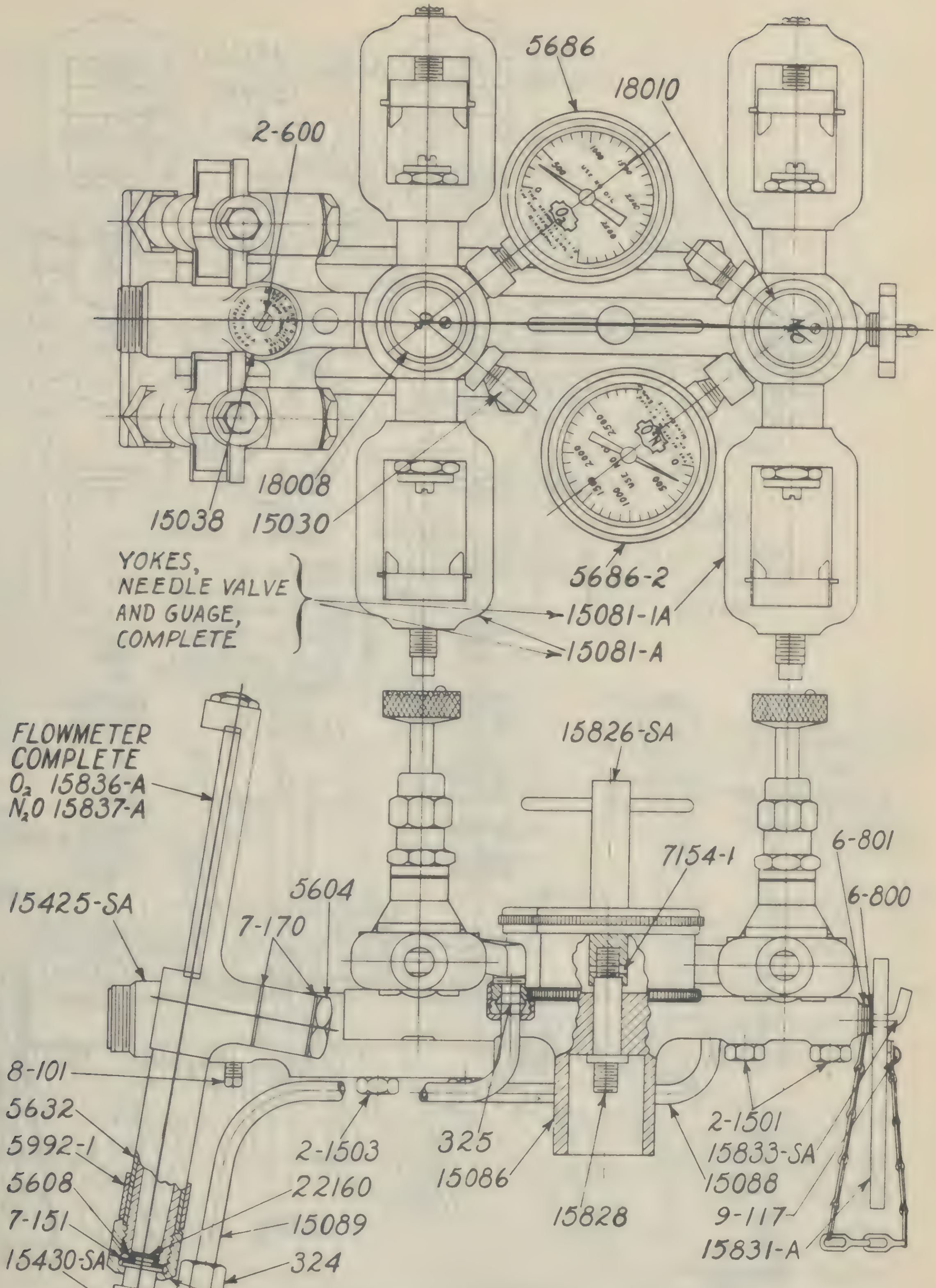
TEST NO. 3 - Flowmeters, Absorber, Ether Vaporizer, Bag, Inhaler Tubings and Inhaler. Close inhaler shut-off valve and exhaling valve. With absorber lever (5908-1) in "down" position and central valve of vaporizer open, fill bag to slight distention. If within 10 minutes bag shows deflation, there is leakage. Test for it as follows:

Apply soap film and watch for bubbles at following locations and tighten connections if needed: (1) needle valve packing nuts (5646), (2) back manifold screws (5604), (3) flowmeter gasket (7-170), (4) union nuts (5620) at bottom of flowmeters, (5) union nuts (324) of pipes connecting yokes to flowmeters, (6) on absorber union nut (4114), packing nut (5646), around top rim of soda lime can--see that the three can lock screws are tightened, around bezels (5914) of inspiratory and expiratory valves, and around positive pressure limiting valve and lung inflation valve on side of expiratory valve, (7) around vaporizer union nut, jar top, dial bezel, funnel, funnel plug, central valve stem and packing nut (14020), (8) all over bag, bag connection, inhaler tubings and inhaler valves. Also turn absorber central valve handle (28021-SA). It should operate smoothly.

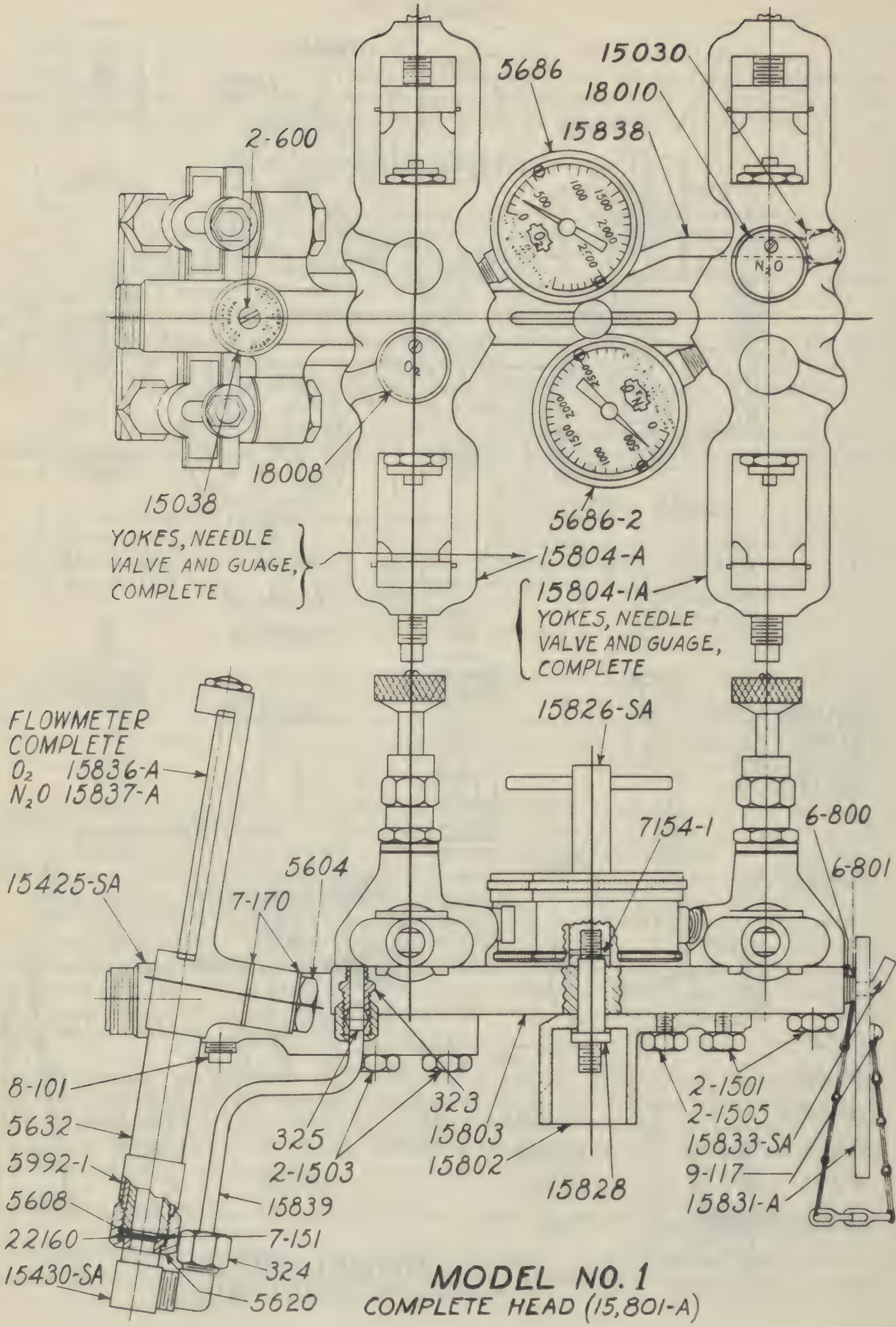
INHALER SHUT-OFF VALVE - (1) Disconnect inhaler and remove mask body, (2) close shut-off valve and exhalation valve. Place thumb over one wye opening, suck on opposite one and close it with the tongue. Vacuum should hold. (3) Open inhaler shut-off valve and using two thumbs close the mask opening and one wye opening and suck on remaining wye opening. Vacuum should hold.

TEST NO. 4 - Hanger Yoke Check Valve --Same as on 3-Gas Kinetometer.

FLOWMETER, O_2 (15836-A), N_2O (15837-A) REPAIR - (Identical on Both Models). Identical to those for O_2 and N_2O on 3-Gas Kinetometer except finish white chrome

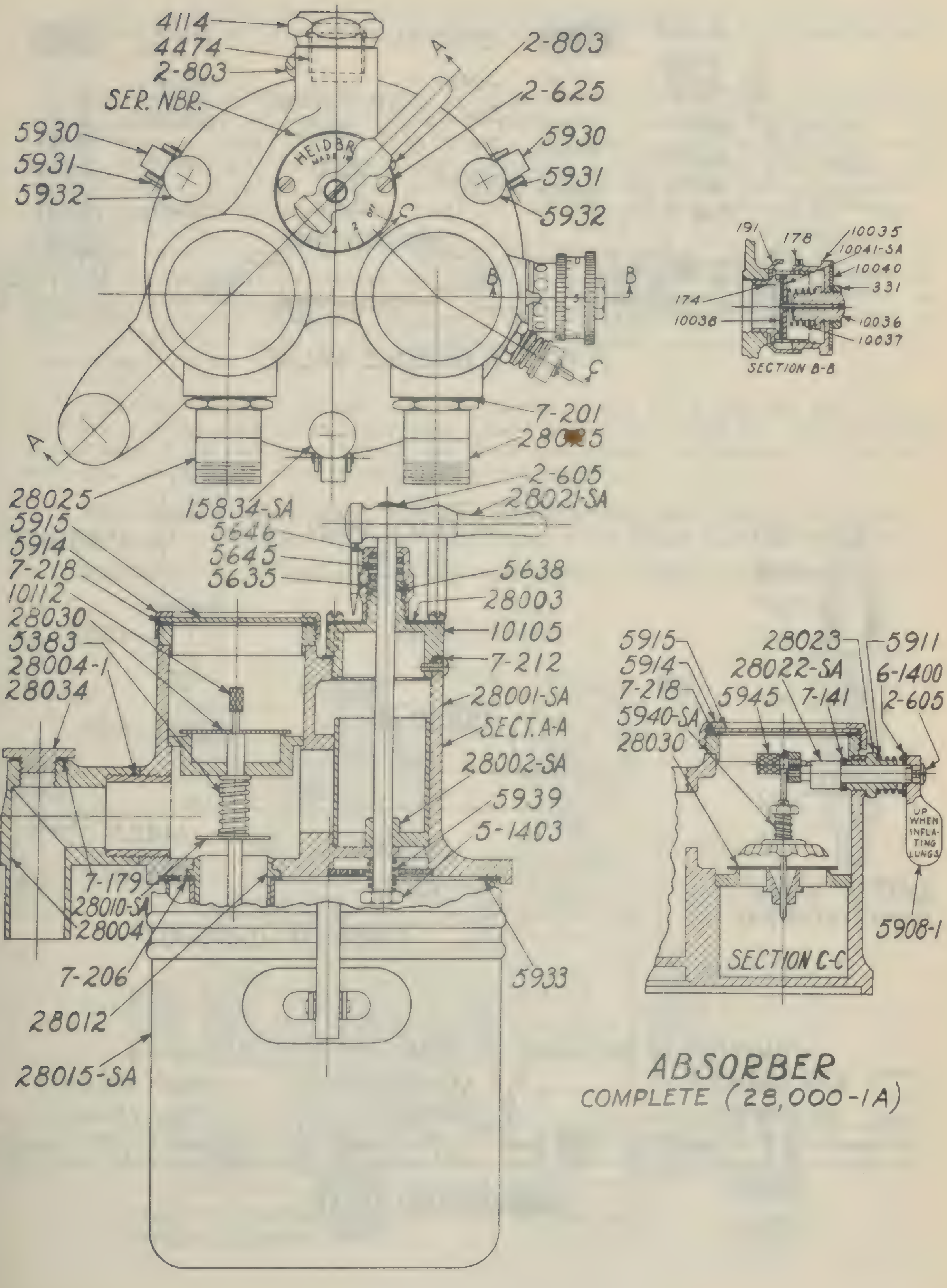


MODEL NO. 2
COMPLETE HEAD (15,860-A)

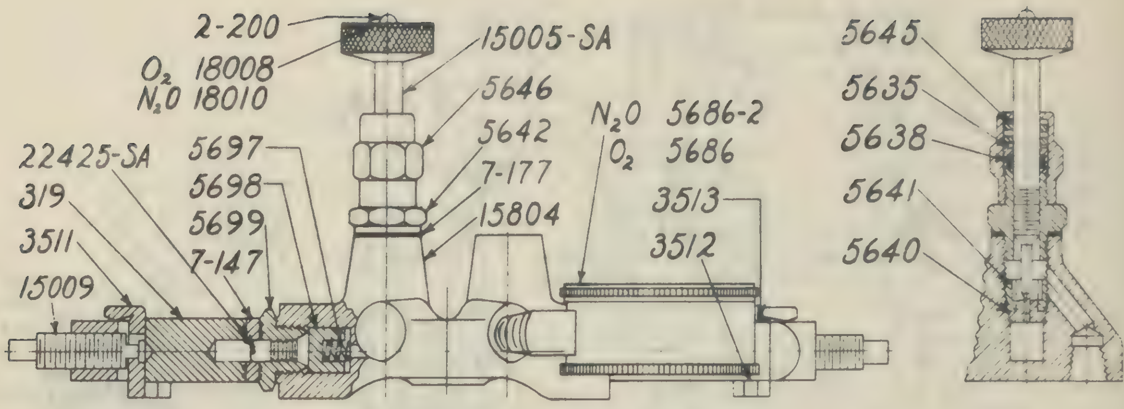


MODEL NO. 1

COMPLETE HEAD (15,801-A)

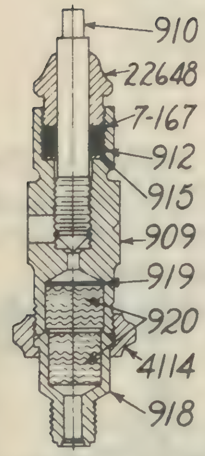


ABSORBER
COMPLETE (28,000-1A)

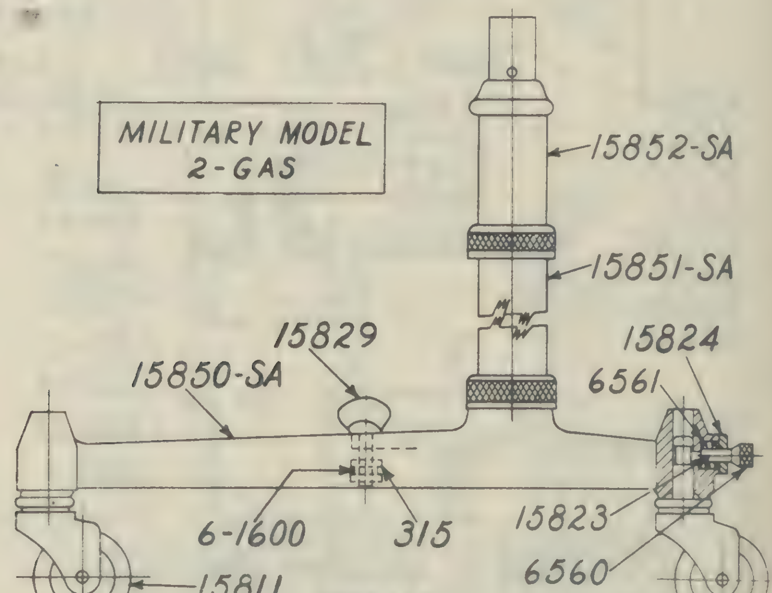


YOKES & NEEDLE VALVE

MILITARY MODEL
2-GAS

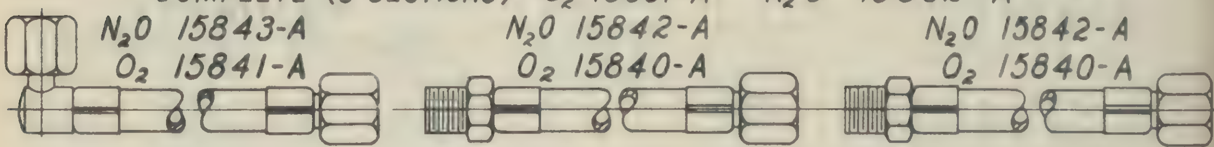


SHUT-OF VALVE
COMPLETE (909-A)



STAND
COMPLETE (15,850-A)

COMPLETE (3 SECTIONS) O_2 15861-A N_2O 15862-A



REGULATOR HOSE

Grasp top end of stem of valve (28002-SA) and pull valve out. Clean outside surface and walls of valve chamber and outside surface of valve with vaseline and put valve back in.

Now screw on cap (10105) tightly, being sure lockscrew hole lines up with screw hole in body (28001-SA) and put in screw (2-803). Put on dial and dial screws. Put packing washers (5638) in cup (5635) invert it (gaskets down) and place it with spring (5645) on valve stem. Now tightly screw on nut (5646). If dial has no retaining screws, position it with calibration "4" in front and centrally located between inspiration and expiration valves and hold thus while tightening nut (5646).

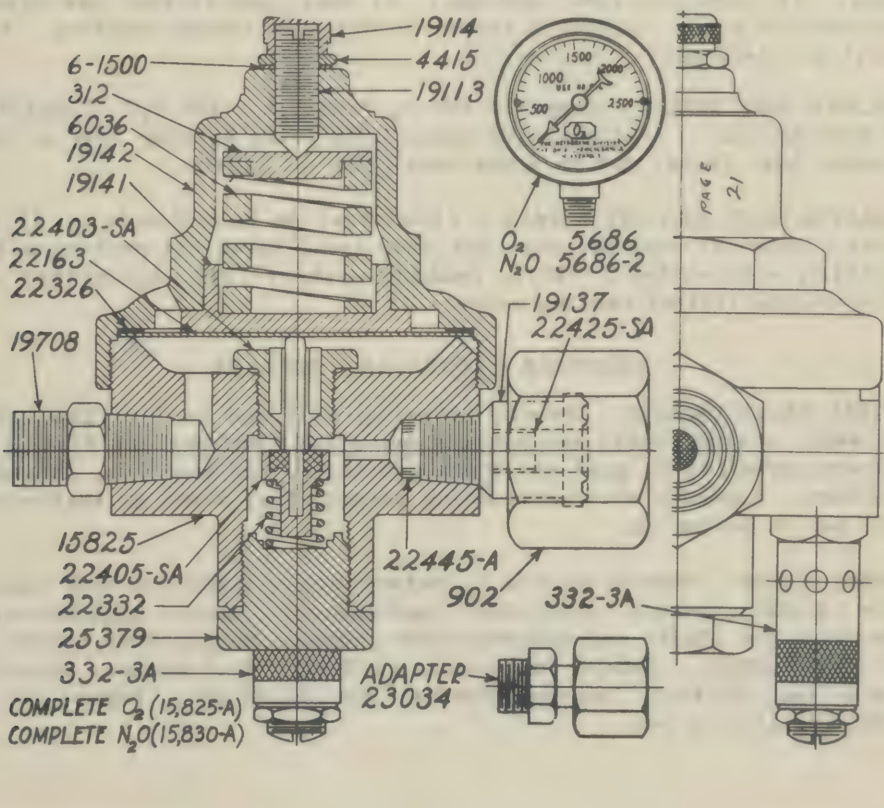
Using handle (28021-SA) as a wrench turn stem of valve until bottom port of valve is closed as viewed through perforated metal (handle lines up with "Shut" on dial). If pointer of handle is not now at "Shut" remove it and put it back on so pointer is at "Shut". Then put in screw (2-605) tightly. Now put spring (5939) on bottom end of stem, screw on nut (5-1403) until it binds snugly. Put on can with long clamp screw at front.

CANISTER GASKET - Loosen canister screws (5932 and 15834-SA) and remove canister. If gaskets (5933 and 7-206) appear undamaged, clean off any corrosion around edge of can and inner tube of can which seal against the gaskets. Put on can and test. If there is still leakage put in new gaskets.

INSPIRATORY, EXPIRATORY, PRESSURE LIMITING AND LUNG INFLATION VALVES - Same as on 3-Gas Kinetometer except Expiratory Valve Crank Shaft is (28022-SA).

REGULATOR, O_2 (15825-A); N_2O (15830-A), REPAIR - (Identical on Both Models).

REGULATOR



and left dial for O_2 is (5660-1), left dial for N_2O is (5654-1) and both flowmeters have transparent dial guard (34029).

HANGER YOKE CHECK VALVES - (Identical on Both Models). Same as on 3-Gas Kinetometer, except yokes are on operative head instead of on regulators.

ETHER VAPORIZER (14000-1A) REPAIR - (Identical on Both Models). Same as on 3-Gas Kinetometer except finish white chrome, and union nut is (507-SA) and union nut stud is (5935).

INHALER, INHALER TUBING, BAG REPAIR - (Identical on Both Models). Inhaler Combination A.

INHALER COMBINATION AIR AND SHUT-OFF VALVE - Same as on 3-Gas Kinetometer.

BAG, INHALER TUBING - Patch or put on new one.

NEEDLE VALVE REPAIR - Identical on both models except yoke assembly forming valve body. (15804-A and 15804-1A); (15081-A and 15081-1A).

SEAT - Unscrew stem (15005-SA) all the way out. Do not *pull* threaded stem through packing which might damage it. Remove packing nut (5646). Screw out bushing (5641) which seals copper seat (5640). With long nose pliers, remove seat and put in new one.

STEM - If stem has picked up coppery metal on its tapered end, or is other-wise damaged, put in new one.

PACKING - With stem out, separate nut (5646) from guide (5642). Remove and examine discs. If three are good, add one. If four, put in four new discs. Screw nut partly back on guide. Screw in stem. Do not push through packing. Now tighten nut and test for leakage.

REGULATOR HOSE REPAIR - Complete for O_2 (15861-A); for N_2O (15862-A). (Identical on Both Models). If tightening union nuts fails to stop leak at hose unions or the rubber hose leaks, put in a new hose. Do not patch.

REGULATOR HOSE SHUT-OFF REPAIR - (Identical on Both Models). If tightening packing nut (22648) of shut-off does not stop leak, screw off packing nut and screw out stem (910) with washer (7-157), packing washers (912) and washer (915) attached. Put in new leather packing washers.

ABSORBER (28000-1A) REPAIRS

CENTRAL VALVE PACKING - Remove screw (2-605) and handle (28021-SA), packing nut (5646), spring (5645) and packing cup (5635) and packing discs (5638). If packing discs appear to be good and there are three, add one disc. If four, put in four new discs. Assemble all parts, being careful that discs go inside packing cup and cup is put on bottom up.

CENTRAL VALVE - Remove absorber, detach ether vaporizer and tubings. Remove screw (2-605), handle (28021-SA), packing nut (5646), together with spring (5645), packing cup (5635) and packing discs (5638). Remove dial screws (2-625) if any, and dial (28003). Remove lock screw (2-803). With spanner wrench (10-144) remove valve cap (10-105). Remove absorber can (28015-SA). Remove nut (5-1403). Spring (5939) will drop out.

GAUGE - If defective put in new one as follows: Coat stud threads with sealing graphite, being careful not to get any in or on stud end and screw to place.

REGULATOR VALVE (22405-SA) - Remove hex cap nut (25379), spring (22332) and valve (22405-SA) - Open tank briefly to blow out debris. Wipe out valve chamber with clean, lintless cloth. Examine nozzle (22403-SA). If damaged remove bell cap (19142) and loose parts including diaphragm (22163), exposing hex of nozzle. Remove nozzle and put in new one. Put in new valve and assemble all parts tightly.

SAFETY VALVE (332-3A--IDENTICAL to 332-1A on 3-GAS KINETOMETER EXCEPT FINISH) - Leakage usually indicates a defective regulator valve which first should be replaced with a new one. If that does not stop leak, repair.

DIAPHRAGM (22163) - Tighten down bell cap (19142) with wrench (1-425). If this does not suffice remove bell cap and put in new diaphragm as follows: Screw off bell cap. Remove loose parts and diaphragm. Paint outer rim surface of new diaphragm with sealing graphite where it contacts its seat on body (15825). (Use no substitute lubricant containing oil which would ignite in the presence of oxygen under pressure). Put diaphragm and loose parts in place and screw bell-cap on firmly.

McKESSON SMALL TANK UNIT

HOW TO SET UP SMALL TANK UNIT WITH ABSORBER - This unit is packed in one carton facilitating quick assembly. Be sure to remove everything from the carton and use the picture of the unit as a guide for setting up the machine. The regulator tubes are the cloth covered rubber tubes about 1/2 inch in diameter and go between the head of the machine and the regulators. One end is attached securely to the head of the unit. The other end has a hexagon nut and is attached to the regulator. These hexagon nuts should be removed. Be sure they have a fibre washer in them. If they do not, get a washer out of the small envelope furnished. Replace the hexagon nut on the regulator which is labeled the same as the attachment on the head, that is, be sure the oxygen regulator tubes go to the oxygen regulator, etc. Tighten hexagon nut securely with a wrench. Check each one and tighten them securely.

Place the cylinders in the yokes according to the symbol above the regulator on the stand. If using but one cylinder be sure to have the small cylindrical plug in the opposite yoke before opening cylinder. Check for leaks at the top of the tank valve and if a leak occurs, tighten the hexagon nut at the top. If small leak is suspected use soap suds around the connection.

Open cylinder valve and tighten wing screw on the regulator until the hand on the reduced pressure gauge on the head of the machine comes up to the middle of "operating range." When tightening the oxygen regulator wing screw, the reduced pressure gauge on the oxygen side of the head will rise, etc. The Carbon Dioxide regulator does not need any adjustment, as it is set at the factory.

When replacing tanks, be sure to remove *all* of the old fibre washer and replace it with a new one.

McKESSON LARGE TANK UNIT

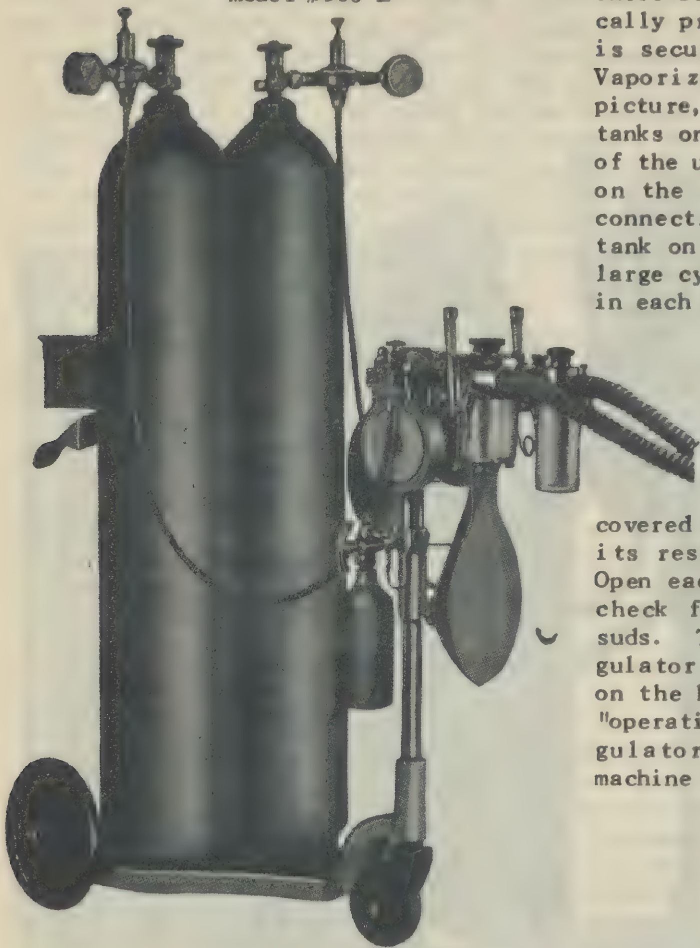
UNPACKING AND SETTING UP - This unit is shipped in a wooden box, the head is shipped in a separate carton. Be sure to unpack everything carefully. Place the truck base on the floor up side down, that is, with the rubber mat toward the floor. Put the two large wheels on the axles and secure them to place with the nut supplied. Place the axles in the back of the base and tighten the large square headed set screws to secure them. Raise front part of the truck (still up side down) about six inches. Put the large swivel caster bracket in place with the three large screws, tightening securely with a wrench. Put the painted post to place in the back of the truck. If separate Carbon Dioxide regulator support is provided, place the regulator bracket over the top of the post and attach with the set screw about six inches from the top. Put tool box assembly on top of the post and tighten the set screw. Place the chrome plated, adjustable, head support post in the front of the truck. Unscrew the large knob and raise the upper part of the post several inches. If Cyclopropane is to be used, attach long tubular cyclopropane support to the head of the unit as per illustration. The head with cyclopropane support attached can now be slipped over the top of the adjustable up right post. If Carbon Dioxide is to be used, put a small amount of shellac on the threads of the CO_2 flowmeter and screw the flowmeter to place in the head, just under the direct Oxygen button. If cyclopropane is to be used, attach the cyclo flowmeter to the absorber before attaching the absorber to the head. Attach the absorber onto the head, using hexagonal nut and leather washer, tighten securely.

Attach the small goose neck metal tube from the Oxygen flowmeter to the Oxygen tee. If cyclopropane attachment is included attach long goose neck metal tube from cyclopropane flowmeter to bottom of cyclopropane yoke. Put large fibre washer in cyclopropane support and screw yoke to place. It is not necessary

McKESSON SMALL TANK UNIT

LARGE TANK UNIT

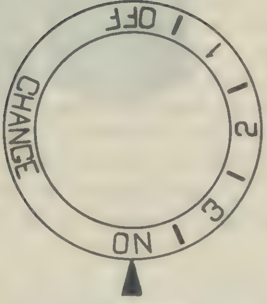
Model #906 L



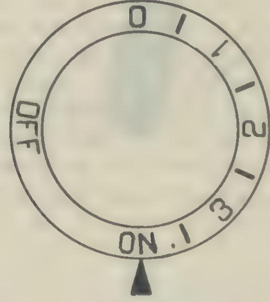
for this yoke to be extremely tight, as there is a plunger assembly that automatically prevents a leak as soon as the tank is secured into the yoke. Attach Ether Vaporizer and rubber tubing as per the picture, using the leatherwasher. Put the tanks on the truck. Standing at the back of the unit, place the Nitrous Oxide tank on the right hand side of the regulator connection on tank valve. Place Oxygen tank on left side, run chain around the large cylinders. Put a large fibre washer in each of the hexagon nuts and attach the regulators to their respective cylinders. Place the Carbon Dioxide in the bracket and secure it with the large hexagon nut furnished. Put a small composition washer in the hexagon nut on the end of each of the cloth covered regulator tubes and attach each to its respective regulator with a wrench. Open each cylinder valve completely, and check for leaks, if doubtful, use soap suds. Tighten the wing screw of each regulator until the reduced pressure gauge on the head goes up to the middle of the "operating range." The Carbon Dioxide regulator does not need adjusting. The machine is now ready for use.

ABSORBER CONTROL DIAL

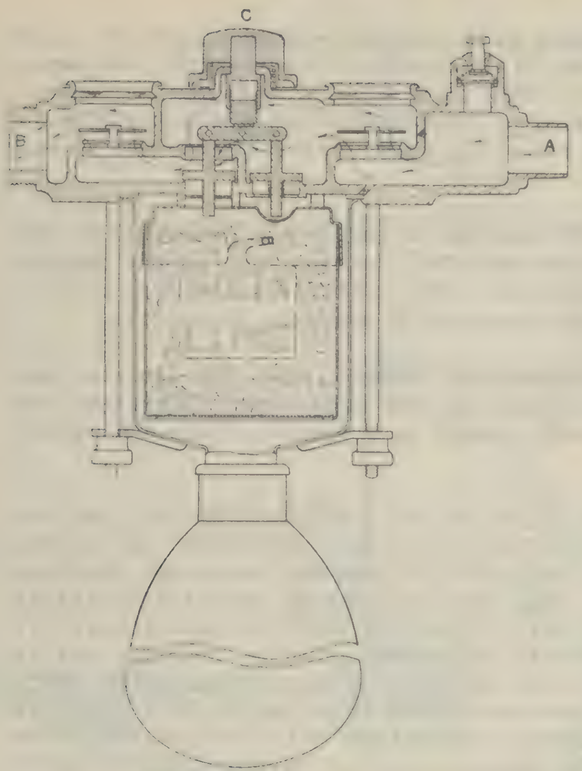
ABSORBER NO. 620



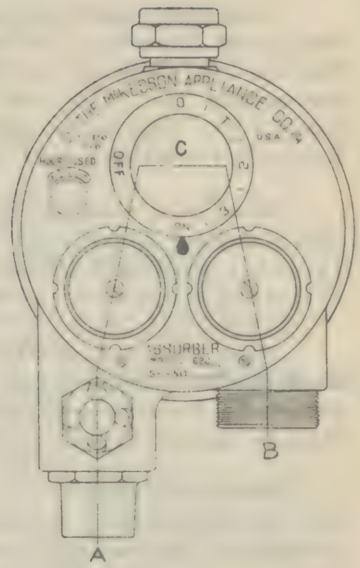
OLD STYLE



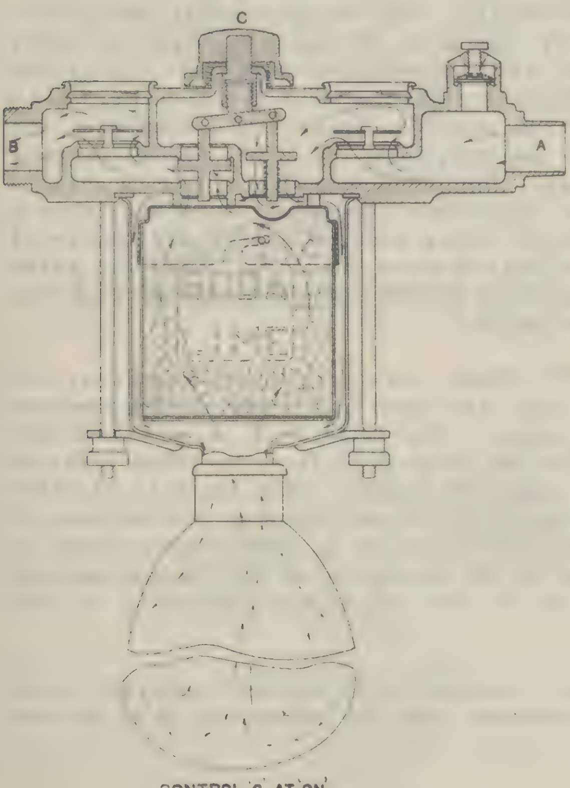
NEW STYLE



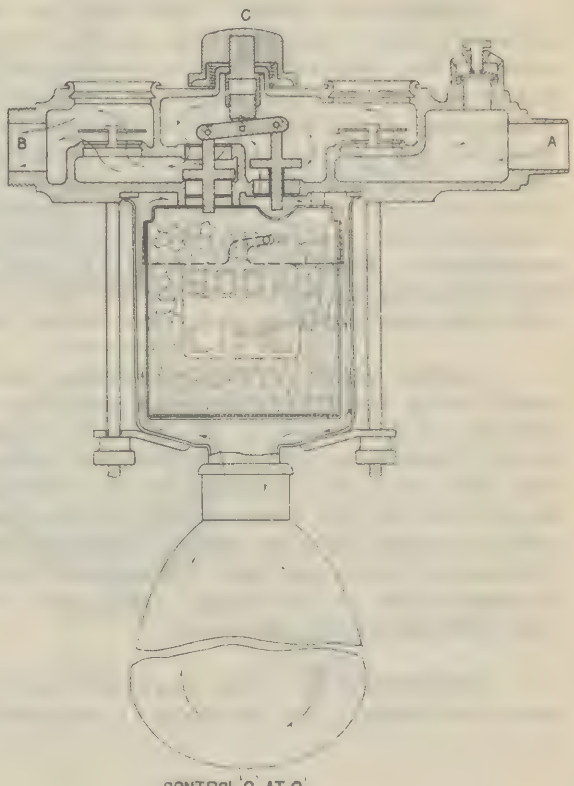
CONTROL C AT OFF



TOP VIEW SHOWING LINE
WHERE SECTION IS MADE



CONTROL C AT ON



CONTROL C AT O

MECHANICAL OPERATION OF MODEL "L" NARGRAF

ABSORBER CONTROL DIAL - Two different dials on the absorber control have been used, however, the mechanical function of the controls are exactly the same. The old style control dials are worded "ON", "OFF" and "CHANGE" while the new dials are worded "ON", "O", and "OFF". The setting of "CHANGE" on the old style dial is exactly the same as the setting of "OFF", on the new style dial. The wording in the future instructions will refer to the new style dial.

When this control is set to "OFF", the absorber is completely by-passed by the gases and the breathing. This setting can be used when the back part of the machine is being used and the absorber is not desired. This setting is also used when inflating the patient's lung under sufficient pressure to make the chest rise.

When this control is set at "O", the breathing is going into the absorber and absorber rebreathing bag, however, it is by-passing the soda lime. Therefore the patient's breathing will become progressively deeper as a result of his own carbon dioxide accumulation.

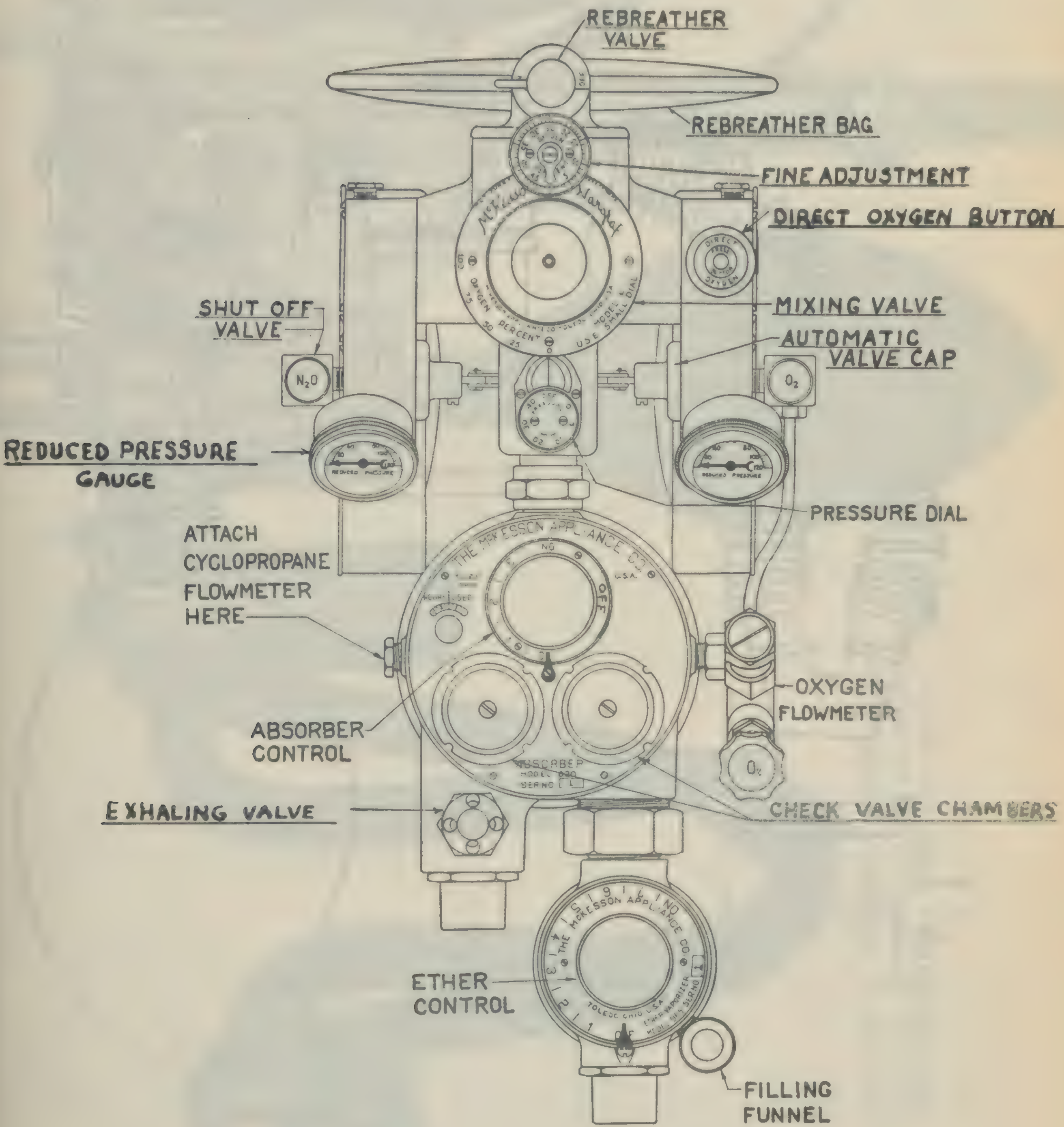
When this control is set at "ON", the breathing is going in a circle, and all the inhalation goes through the soda lime filter. This will not permit any carbon dioxide to accumulate, and therefore the patient will breathe extremely shallow, even more shallow than normal breathing. When this control is set at "2" half of the breathing is going through the lime while the other half is by-passing it, therefore a large amount of carbon dioxide will accumulate quickly, however, not as quickly as when the control is set at "O". The closer this control is set to "ON", the more shallow the patient will breathe and the closer it is set to "P", the more deeply the patient will breathe. Under normal conditions this control should be left at "ON" or very close to it, hence the accumulation of carbon dioxide over a prolonged period is a dangerous procedure.

REBREATHING BAGS - There are two rebreathing bags on this unit; one is located directly beneath the absorber and is connected to the soda lime canister cover. This bag is in direct communication with the soda lime canister. It is the principal rebreathing bag that is used during anesthesia when the absorber is in operation. This bag is also in communication with the breathing system when the absorber control is in the "OFF" position. In this case the gases are by-passing the soda lime and going directly into the bag. The other rebreathing bag is attached to the rear of the head of the machine. The chief purpose of this bag is as a reservoir for the gases while the soda lime is being changed during the course of anesthesia. When the bag is not in use for this purpose the lever admitting gases into this bag is kept in the "OFF" position. See subsequent instructions regarding this bag when changing soda lime during anesthesia.

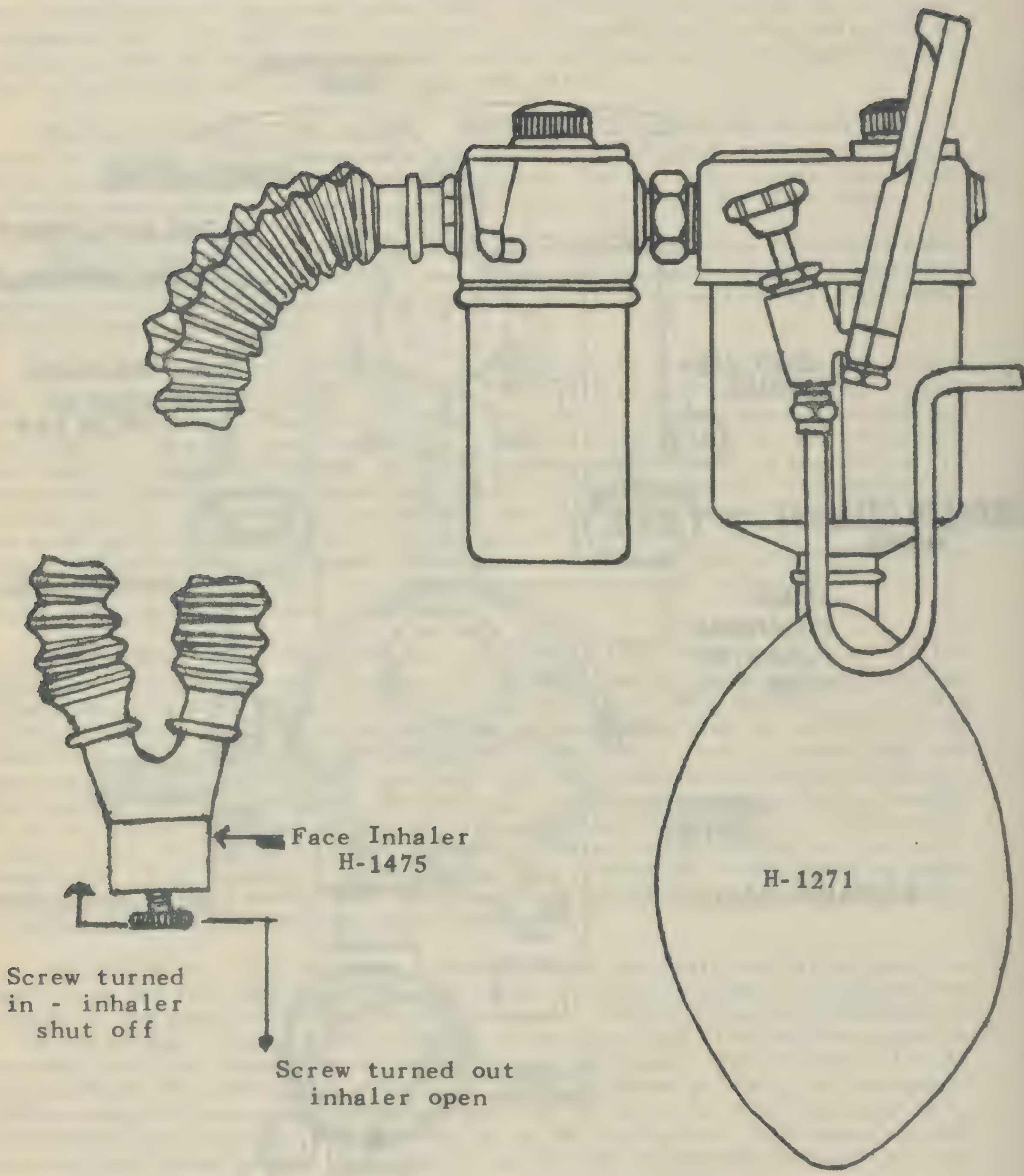
MIXING VALVE - (Oxygen Perdent Dial) - These two dials work in unison, the small being for fine adjustment while the large dial permits a rapid change from one extreme to the other in the mixture of the gases. The small dial is numbered only to 50, therefore, it is advisable to refer to the large dial first and then refer to the small dial for the mixtures in between 0 and 50% Oxygen. This one pair of dials mixes both of the gases. The numbers are given in Oxygen percent, the balance of 100% is always Nitrous Oxide. Example: When dial is set at 0, 100% Nitrous Oxide is delivered to the patient. When dial is set at 10, a mixture of 10% Oxygen and 90% Nitrous Oxide is delivered. When dial is set at 100, all Nitrous Oxide is cut off and 100% Oxygen is delivered.

PRESSURE DIAL - The pressure dial will automatically maintain a given pressure uniformly. The pressure is entirely separate from the percent so that one may

TOP VIEW OF MODEL L NARGRAF HEAD SHOWING THE CONTROLS



SIDE VIEW MODEL L NARGRAF HEAD
TOP VIEW OF FACE INHALER "Y"



SIDE VIEW OF THE MODEL L HEAD SHOWING
ALSO THE CO_2 ABSORBER, BASAL OXYGEN VALVE,
ETHER VAPORIZER, TUBES AND INHALER.

be changed without disturbing the other. When turned to "OFF" the entire machine is cut off so that no gases will deliver even though the patient is inhaling. When pressure dial is turned to "O", no gases will come from the machine except when the patient is inhaling. When the dial is set above "O", the gases will flow from the machine until they meet the resistance of the setting of the dial. As soon as this resistance is met, the machine automatically cuts off until the pressure within the breathing systems falls below that pressure. Then the machine automatically delivers again. Therefore, a given pressure is maintained uniformly. From an economical standpoint, it is important that no leaks occur around the mask and that excessive leaks do not occur at the exhaling valve. In such a case the breathing system would not meet the resistance of the pressure set and the machine would continue to flow.

EXHALING VALVE - The exhaling valve is opposite the Ether Vaporizer just in front of the Absorber. It is a pressure breaker in the breathing system and has a small screw on the top. When the back rebreather valve is "ON", the dial on the exhaling valve should be tightened down so a little, *and only a little,* of the exhalation escapes through this exhaling valve at the end of the exhalation. If the rebreather bag is inflated, and after several breaths none of the exhalation is escaping at the exhaling valve, loosen the exhaling screw until a little does escape. If too much is escaping at the valve, tighten down on same.

DIRECT OXYGEN - By pressing the Direct Oxygen button, all Nitrous Oxide is cut off and straight Oxygen is delivered to the patient under sufficient pressure to inflate the lungs, but not enough pressure to harm them. To get this much pressure into the lungs, it is necessary to tighten down screw on top of the exhaling valve before you press down on the Direct Oxygen button. As soon as you see the chest rise, release button and raise the mask. The reason for tightening down on the exhaling valve before pressing the Direct Oxygen button is that the exhaling valve is a pressure breaker and will not permit any more pressure in the breathing system than it is set for. Therefore in resuscitation, it is necessary for it to be tightened down so that the higher pressure may go into the lungs. The method just described is for resuscitation only, and should not be used in ordinary anesthesia. To correct deep narcosis quickly a small quantity of Oxygen may be administered by use of this button.

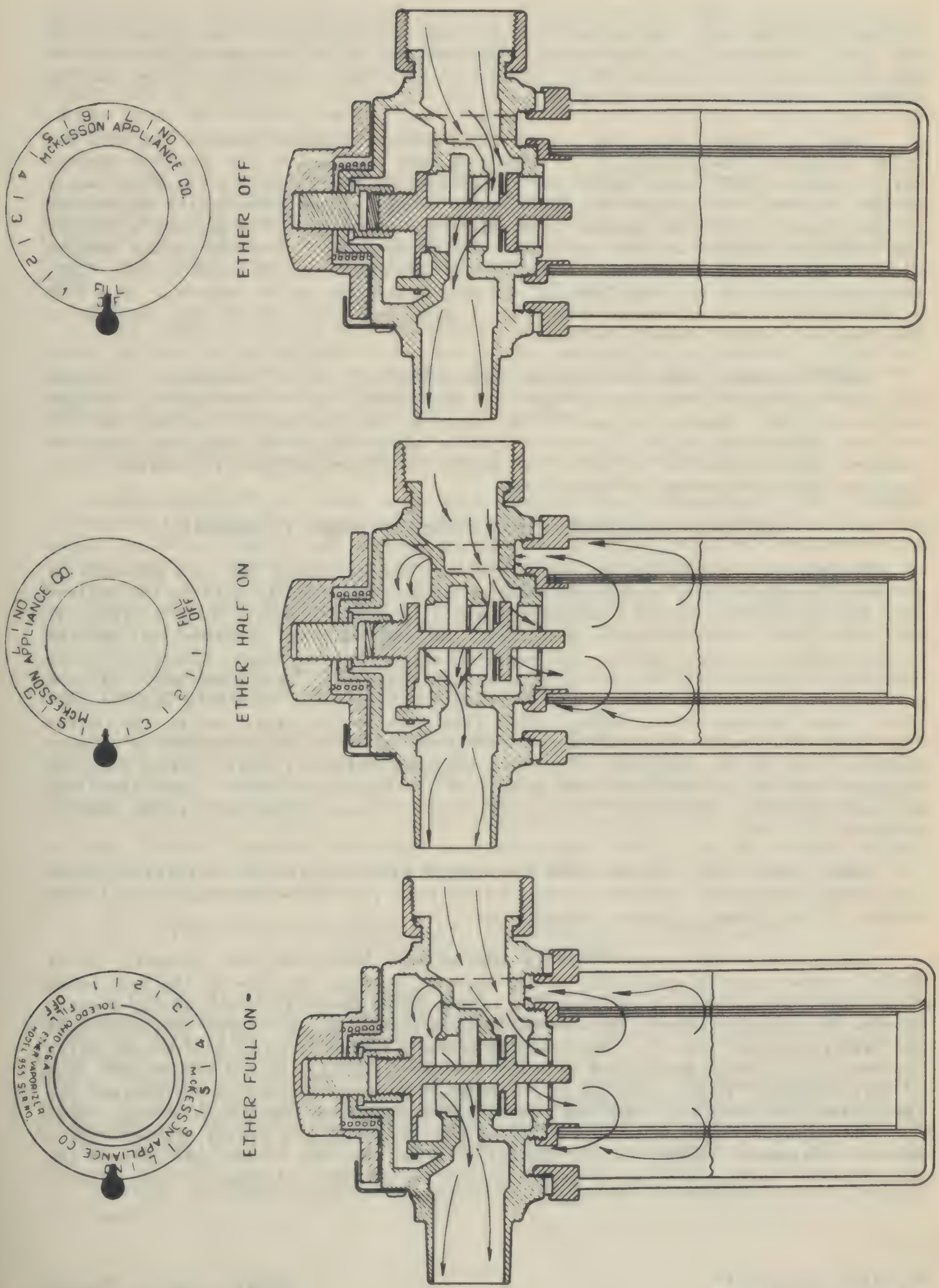
ETHER VAPORIZER - When the Ether Vaporizer control is turned to "OFF", no vapors are carried to the patient. When the Ether control is turned to 1, one part of the breathing is going through the vaporizer while seven parts are still going to the patient. When set at 4, approximately half goes through the vaporizer and half goes direct. When set at 6, approximately three fourths goes through the vaporizer and one fourth goes direct. When set at "ON", all of the breathing goes through the vaporizer.

To fill the jar turn the control to fill, and remove the screw from the funnel. Pour the Ether in slowly. After filling, replace the funnel screw.

FLOWMETERS - McKesson flowmeters are dry and self cleaning, and rarely need attention. It is not injurious to flow gas at higher rates than indicated.

RUBBER GOODS - When not in use, the rubber breathing tubes will last longer if hung up straight. All of the exposed rubber goods will give longer service if kept in a dark cool place when not in use.

HOW TO INSERT SODA LIME - The Soda Lime Canister cover is released by loos-



ETHER VAPORIZER #965

ening the knurled knobs at the bottom and giving the canister cover one eighth turn to the left. The soda lime canister is also removed by giving it one eighth turn to the left. The Soda Lime is placed in the canister, which is then replaced on the absorber body. The canister cover is then replaced and secured by the two knurled knobs.

WHEN TO CHANGE SODA LIME - Soda Lime absorbs Carbon Dioxide. Carbon Dioxide stimulates respiration. If no Soda Lime were used, or if the absorber control were turned to "OFF" while using the closed system, the patient's breathing would become progressively deeper and deeper as a result of the stimulation by his own Carbon Dioxide. When the absorber control is turned to "ON", the patient's breathing should be uniform and not too deep. If the patient's breathing starts getting deeper and deeper progressively even though the absorber control is turned full "ON", this would indicate the Soda Lime is exhausted and needs to be replaced. The life of Soda Lime varies extremely from 1 to as many as 8 absorbing hours. Storage of the lime will often effect its life.

HOW TO CHANGE SODA LIME DURING ANESTHESIA - If it is necessary to change the Soda Lime during anesthesia, turn the rebreathing valve on the back of the gas machine to "ON". Squeeze as much of the gases out of the big rebreathing bag into the back rebreathing bag as is possible. While squeezing on the large bag, turn the absorber control tightly to "OFF". The patient will now continue to breathe in the back bag while you change the Soda Lime.

SERVICE SUGGESTIONS FOR McKESSON MODEL L NARGRAF

Pressure up to 2000 lbs. is compressed into the cylinders and this pressure is released through relays, each relay reducing it until it finally gets to the patient at a low pressure. The most common trouble is a leak somewhere in the line. To test for a leak, open the oxygen tank valve, see that both the pressure dial and the reduced pressure gauges register the supply present. Be sure Oxygen flowmeter on the absorber is turned off, so the float does not register. Turn tank valve off and watch the tank pressure gauge, if the pressure falls *fairly* rapidly a leak is present. Open the tank valve again. This time unscrew the wingscrew on the Oxygen Regulator. You can now find out whether the leak is on the high pressure or reduced pressure side of the regulator by turning the tank valve off again. Watch both the tank pressure and reduced pressure gauges to see which one drops. This same test procedure is made in testing for a leak in the nitrous oxide and carbon dioxide system.

SMALL TANK UNIT - If the leak is on High Pressure Side of Regulator. Open tank valve and apply soapsuds around valve stem just above hexagon nut of tank valve. If it leaks, tighten hexagon nut.

Apply suds around washer between face of tank valve and yoke plunger. If it leaks, remove tank and remove *ALL* of the washer. Examine the face of the tank valve to be sure there are no deep scratches in the valve where it contacts the washer. Examine the circular channel around the valve outlet to be sure washer particles have not been compressed into it. Examine yoke plunger (2255R3), to be sure washer particulars have not been compressed into the circular channel. *Do not scratch the face of this plunger.* If it is difficult to clean this channel, unscrew the hexagon nut that holds the yoke, tilt the yoke upward and force the plunger down through yoke. Soak the plunger in hot water until the washer particles are easily removed with a pointed instrument. NOTE: If the plunger will not come out of the yoke, remove the yoke from the machine and put it in water with the plunger. In such a case, examine

the yoke. It probably has been abused to such an extent the sides have been stretched and sway inward. If so, the entire yoke has been strained so badly the yoke casting is pinching in on the plunger. If new yoke and plunger (2255 for Oxygen) are not available and the one you are working on is beyond repair, "borrow" a yoke from the Carbon Dioxide regulator until a new yoke can be secured. An anesthetic can be given without Carbon Dioxide.

Examine the small wire screen filter inside regulator to be sure dirt has not accumulated at this point. If this screen is dirty, remove it and clean with ether. Moisten large fibre washer (2320) to soften it, and put the washer in place before replacing the yoke. After replacing the yoke, put *only one* clean No. 1065 fibre washer over the plunger. Be sure *not* to handle these washers with *greasy or oily* hands.

Many yokes are ruined by negligence of the operator to remove *all* of the old washer before replacing with a new one, or by reusing the old washer. In either case, more and more force is required on the tank securing handle to prevent a leak. Sooner or later the threads either strip or the yoke is strained beyond repair. The operator should be instructed to watch this closely.

Test all the different gases the same as you do the Oxygen.

LARGE TANK UNIT - If leak is on High Pressure Side of Regulator. This trouble is not experienced with large tanks since the regulator screws directly onto the tank. The seven eighth inch threads on commercial oxygen tanks are different from the one half inch threads on large medicinal tanks. All regulator nuts are made to fit one half inch thread medicinal tanks. If commercial tanks are used, an adaptor must be screwed onto the tank before the regulator will fit. No washer is required on commercial valves but one must be used between the regulator and the adaptor.

Threads on large Ethylene tanks are 1/2 inch *left hand* to prevent this regulator from being switched with an Oxygen regulator.

Fibre washer No. 2320 should not be reused. Examine the face of the tank valve to be sure no deep scratches are present. Open the tank valve slightly and blow a little gas out to remove any dust that might have settled in the valve during storage, then turn valve off. Examine filter screen in regulator. Moisten No. 2322 washer, to soften it, and put it in the regulator, then tighten regulator securely to tank. Tighten regulator onto tank pressure gauge (2300). Use one wrench on each to tighten these. Check tank valve stems and tighten hexagon nut if it leaks. Recheck for high pressure leak.

THE FOLLOWING CHECKS ARE APPLICABLE TO BOTH LARGE AND SMALL TANK MACHINES

TO CHECK FOR REDUCED PRESSURE LEAK - Open tank valve and tighten down on regulator wingscrew until reduced pressure gauge on head of machine register in the middle of "Operating Range". Apply suds over one of the four holds in regulator bell (2220). Hold your fingers over the other three holds all at once and see if bubbles blow up on the one with suds on it. If it does, the regulator diaphram leaks. To repair this is a factory job. Do not attempt to solder since it requires a special type of tempering. An ordinary soldering job might damage the regulator so that combustion might blow it apart when tank valve is opened.

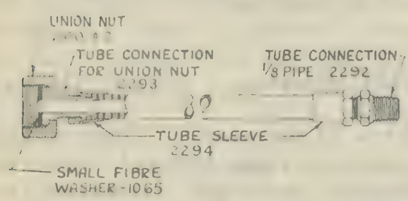
"Borrow" the Carbon Dioxide regulator and return the damaged one to the factory for repair.

On the lower part of the regulator, that is, opposite from the regulator bell above described, a removable section screws into the regulator body. A seam will be noticed where these parts go together. Apply suds all around this seam to be sure no leak occurs. If it does, use a wrench on the large hexagon part just below this seam and remove this part. Clean old shellac from threads, apply new shellac and replace.

Be sure a (No. 1065) fibre washer is between (No. 1100-A2) hexagon nut (on end of regulator tube) and the regulator. Tighten this nut securely.

HOW TO REPLACE REGULATOR TUBING CONNECTION - Examine cloth covered regulator tubing. Be sure no leaks occur in the tubing or at the connections on either end. If leak occurs the tubing should either be replaced or cut back. In replacing this tubing, it should be put on the swivel (Regulator end) connection first. Otherwise the tubing will twist up when you put it on the connection.

Unscrew tube sleeve No. 2294 and pull sleeve off of old tubing. Cut about one inch of the tubing off evenly. Put end of tubing into *unthreaded* end of the tube sleeve. Force tubing (while twisting) about half way through the tube sleeve, up to where the threaded section starts. Be sure the cloth cover does not peel back.



(Sometimes an old piece of tubing that has become stretched will not go in the tube sleeve without the cloth peeling back. In such a case slit the end of the tubing lengthwise about one inch and peel the cloth back from the rubber this much. Cut the exposed rubber tubing off crosswise. Pull the cloth part back over the end and it will serve as a lead for threading through the tube sleeve. Use pliers to pull the tubing all the way through the tube sleeve. Cut end of tubing and cloth off cleanly. *Carefully* back the tube sleeve off the tubing until the end of the tubing is just off the threads.)

Put a small amount of rubber cement on the *outer smooth tapered* part of No. 2292 tube connection. Be sure the threads on both connections are clean. Put the tube sleeve with tubing over this connection, and as you screw it to place with your fingers, let the rubber tubing revolve freely so it will not hold back as the tube sleeve goes forward. After tightening this firmly with your fingers, use a wrench to finish tightening fairly firm. When finished, the tubing should withstand a strenuous pull without coming loose from the connection.

Apply suds around fibre washer on hexagon nut of elbow No. H-1017. If leak shows up tighten the hexagon nut. This should correct the leak. If it does not, remove the washer, apply shellac to both sides of it, and replace.

Apply suds at threads of connection between right angle body H-1017 and the head. If leak occurs, remove right angle body H-1017, apply shellac to threads, and replace.

Apply suds at both ends of metal oxygen supply tube (H-1299). If leak occurs tighten the hexagon nuts. Shellac should not be used on these threads. The tubing is flanged and tightens against the connection.

Apply suds at connections where oxygen tube adaptor (H-1302A) screws into both

"T" Connection (H-1302) and base of flowmeter part (H-1266). If leak occurs, remove this part H-1302A, apply shellac to threads and replace.

A flake of foreign matter, or a worn out, or punctured rubber diaphram (No. H-1020) will prevent the pressure dial from cutting the pressure completely off. From the outer side of the head remove the two semi-round headed screws (H-1086) that holds automatic valve cover (H-1018) in place. *In replacing this, be sure flat side of plunger (H-1021) goes against the rubber.*

Test the reduced pressure line again. You should have corrected any leak that might have been present. If it is the oxygen line and a leak still persists, the direct oxygen valve might be leaking. To check for a leak in the direct oxygen valve, unscrew the small screw that holds the red tipped pointer on the "Fine Adjustment" small oxygen percent dial. Grasp both the large "Oxygen Percent" mixing dial and the small "Fine Adjustment" dial and lift both of them straight up at the same time. The large chamber has a film of grease on it. Do not finger this or let any dirt get on it. Inside the well (where the mixing dial came out) is a small hole directly in line with the "Direct Oxygen" button. This hole is about three fourths of an inch from the top and is in the center of a shallow countersunk square which is about three eighths inch square. Put a film of suds over this small hole while the oxygen is turned on and see if it blows a bubble. If it does, replace the direct oxygen valve stem (H-1064).

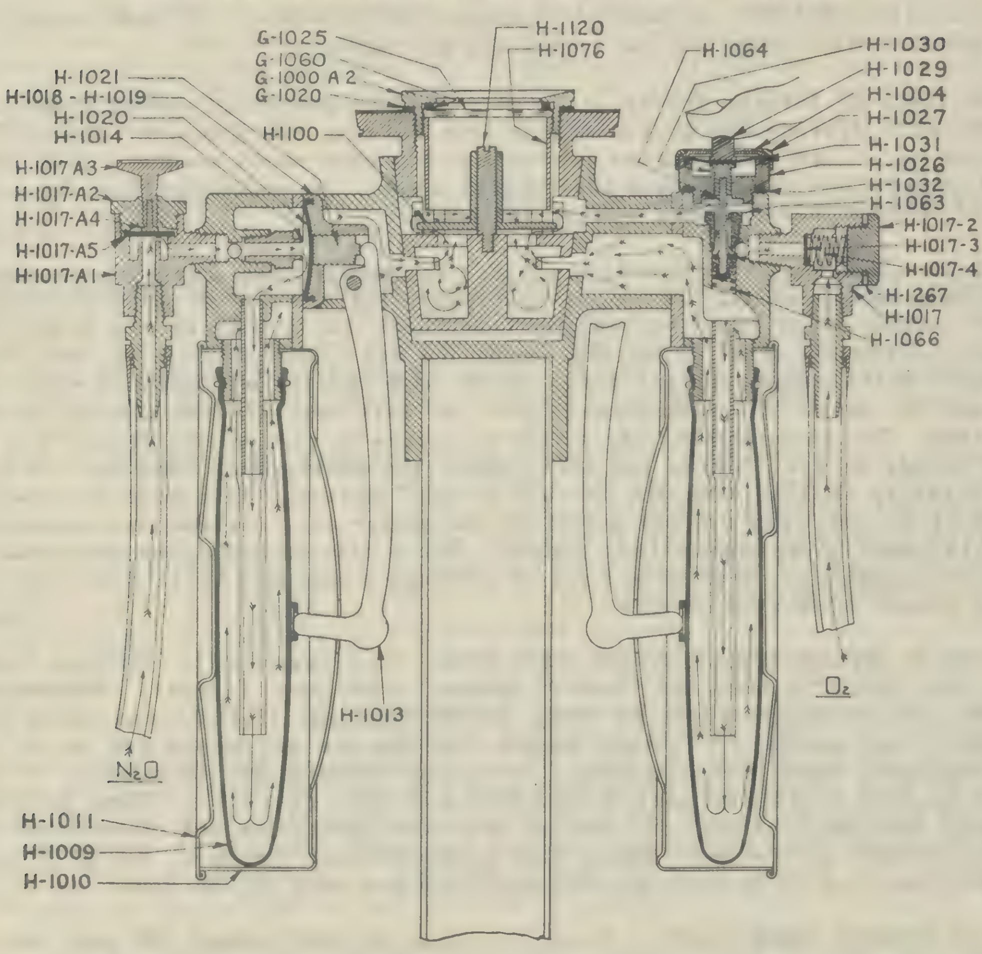
HOW TO REPLACE DIRECT OXYGEN VALVE STEM - Turn Oxygen off. Unscrew diaphragm cover nut (H-1027) from the "Direct Oxygen" with your fingers. Remove button (H-1029), Direct Oxygen Plate (H-1004), Rubber diaphragm (H-1031) and inside plunger (H-1030). Use special "T" handle wrench that has one pin on the end of it, to remove "Emergency Valve Body" (H-1026). With this removed, use the special "T" handle socket wrench to remove nozzle (H-1063) and stem (H-1064). Then lift spring (H-1066) from well. Clean old shellac and other particles out of well and off of nozzle (H-1063) with ether. Blast some oxygen through the well, not only to clean the well but also to be sure no more particles are back in the line.

TO REPLACE THESE PARTS - Stretch spring (H-1066) about 20% and put it in well. Be sure the rubber washer on the new valve stem is clean and put short end of stem in top of spring. Put a film of shellac on *threads only* of nozzle (H-1063), slip it over the stem and screw to place with special "T" handle socket wrench. Replace valve body with special wrench. Replace inside plunger (H-1030), diaphragm button, oxygen plate, and tighten to place with diaphragm cover nut (H-1027). Allow a few minutes for shellac to dry. Turn Oxygen on and check small hole for leak.

In replacing Mixing Dials, be sure both the small and large dials register exactly "O" when you fit the cogs together and drop them to place. Replace pointer and screw.

HOW TO CHECK ABSORBER CHECK VALVES - If new soda lime is being used and with the absorber control to "ON" and the patient continues to breathe deeper progressively, the check valves under the glass crystals in the head are probably not functioning properly. To check these for efficiency disconnect the inhaler "Y" of the end of the exhalation rebreathing tube which is connected to the exhaling valve side of the absorber and try to breathe into the inhalation breathing tube which is connected to the ether vaporizer. Watch the bag at this time and be sure it does not inflate when you try to exhale into the tube. If it does, the check valve on that side of the machine is defective. To check the exhalation breathing tube, reverse the procedure by holding your hand over the end of the inhalation breathing

SECTIONAL VIEW OF NARGRAF HEAD



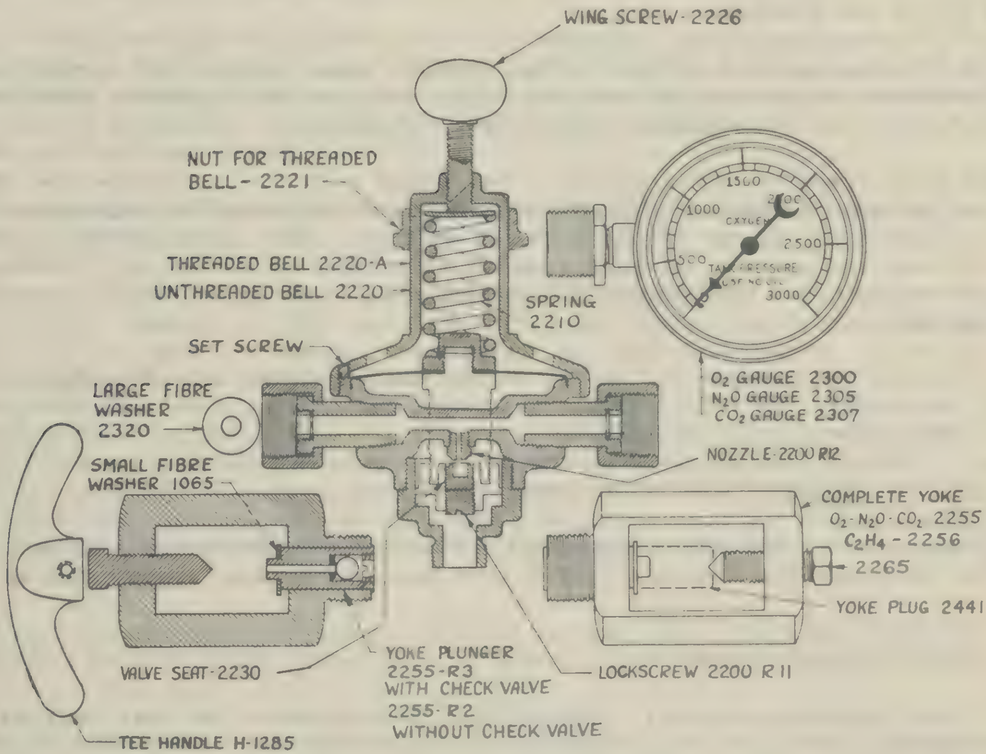
H-1004	Direct Oxygen Plate	H-1026	Emergency Valve Body
H-1009	Supply Bag	H-1027	Diaphragm Cover Nut
H-1010	Supply Bag Housing R.H.	H-1029	Outside Plunger (Emergency Valve)
H-1011	Supply Bag Housing Cover	H-1030	Inside Plunger (Emergency Valve)
H-1013	Gas Lever	H-1031	Diaphragm (Emergency Valve)
H-1014	Nozzle	H-1032	Emergency Valve Body Gasket
H-1017	Right Angle Body	H-1063	Emergency Valve Nozzle
H-1017-2	Plug	H-1064	Emergency Valve Stem Complete
H-1017-3	Filter Screen	H-1066	Emergency Valve Spring
H-1017-4	Filter Spring	H-1076	Gland Nut
H-1017-A1	Supply Valve Body	H-1100	Check Valve
H-1017-A2	Supply Valve Bonnet	H-1120	Check Valve Stud
H-1017-A3	Supply Valve Stem	H-1267	Valve Gasket (2 Required), each
H-1017-A4	Supply Valve Plunger	G-1000A2	Mixing Key Cap
H-1017-A5	Supply Valve Diaphragm	G-1020	Glass Disc Washer
H-1018	Automatic Valve Cover R.H.	G-1025	Glass Disc
H-1019	Automatic Valve Cover L.H.	G-1060	Cap Washer
H-1020	Automatic Valve Diaphragm, Pr.		
H-1021	Automatic Valve Plunger		

tube and try to inhale through the exhalation tube. Watch the bag at this time and should it deflate while you are trying to inhale, the check valve on that side of the absorber is defective.

TO REMOVE AND CLEAN CHECK VALVES - Unscrew the threaded rim over the glass crystal using the Spanner wrench which is furnished with this machine. Unscrew ether vaporizer and insert screw driver through the opening in the absorber head. Push the glass crystal out with the screw driver. To remove the other glass crystal, (exhalation), bend the hook on the end of a heavy wire such as a coat hanger. Disconnect the absorber head from the machine and insert this hook wire through the back opening into the absorber and push the glass crystal out with the hooked wire. After the glass crystals are removed unscrew the check valve studed screws and examine and clean check valves. These valves should be perfectly flat before being replaced.

REMOVAL AND REPLACING OF REPAIRED OR NEW VALVE SEAT IN THE HIGH PRESSURE REDUCING AND REGULATING VALVE (REGULATOR) - Should there be no new seats available

McKESSON HIGH PRESSURE REDUCING AND
REGULATING VALVE



to replace a defective one, care should be taken in removing the defective seat as it will have to be re-used. Sometimes a poor pressure holding seat may be refaced by gently, but firmly rubbing the composition facing against emery cloth. Care should be taken in rubbing the facing in that unevenness will render the seat practically useless. It will not seat properly if uneven so the facing must be sanded

uniformly. Simply place a piece of emery cloth or very fine sandpaper on a firm flat surface, preferably glass. Holding the seat firmly, rub the seat facing across the paper evenly to assure getting an even surface and at the same time removing the indentation in the seat.

When you have established a smooth surface, insert the repaired seat and compensate for the slight loss of surface by setting the seat about one-fourth turn additional thread depth in step 11 in the following instructions.

On a McKesson gas machine having a reduced pressure gauge a defective regulator seat will be evidenced as follows: With the wing screw fully released (turned outward in the counter-clockwise direction) and turning on the cylinder on this regulator, the needle of the reduced pressure gauge gradually climbs. This indicates that the seat, which is in the closed position, is not holding.

Another indication of a deficient main seat will be--with the machine set for operation, that is, the reduced pressure gauge needle in the "Operating Range,"--if this needle continues to rise after no further pressure from the wingscrew, this indicates that the seat is not holding. Sometimes after the machine has been in operation during anesthesia, the needle on the reduced pressure gauge may rise beyond the "Operating Range" for which it was set at the start. This is also an indication that the seat is not holding. See previous paragraph for repair of seat if a new one is not available.

On a McKesson machine without a low pressure gauge a defective seat will be evident by escape of pressure through the safety valve on the regulator itself when there is pressure on the regulator from an open cylinder.

With both types of the previously described regulators, follow the steps exactly as follows in removing the defective seat and replacing the repaired or new seat.

1. Start with the tank turned off and the wing screw (2226) fully turned out (counter-clockwise).

2. Unscrew the hexagon nut on the end of the regulator tube directly underneath the regulator. On removing this metal end connection, note that there is a washer at this union.

3. Unscrew the lock screw from inside regulator.

4. Turn down on the wing screw about 6 turns after meeting resistance. This pushes the seat away from the nozzle and thus prevents further indentation of the seat.

5. Remove regulator seat.

6. Turn the wing screw all the way up. This returns the seat carriage to normal position.

7. Stick the eraser end of an ordinary pencil into the regulator and twist against the nozzle several times to clean the nozzle.

8. Open tank valve to blow out any particles remaining in the regulator.

9. Screw repaired or new regulator seat into the regulator *with finger*

pressure *only* on the screwdriver until the seat just touches the nozzle inside.

10. Screw down on the wing screw for 6 or 8 turns after meeting resistance.

11. Put screwdriver back on the regulator seat and turn it to the right exactly one turn if you are inserting the new seat. If you are using a repaired seat, turn it to the right 1-1/4 turns. No resistance will be met this time as the seat is away from the nozzle.

12. Again unscrew the wing screw. This brings the seat firmly against the nozzle so that in the next step the seat will not turn.

13. Screw lock screw to place fairly tight against the regulator seat. Since the seat is against the nozzle, its position will not be disturbed by the lock screw.

14. Be sure fibre washer is in place and tighten hex nut on the end of regulator tubing to place on the regulator.

15. Open tank valve, tighten down on wing screw till the hand in the reduced pressure gauge registers to the extreme right of operating range.

16. Then unscrew the wing screw.

17. Turn tank off and release tank from regulator until you hear the pressure escape (this is the high pressure). Then tighten tank back to regulator. Reduced pressure gauge should still be registering. Leave the machine exactly like this for a full hour if possible. This allows the regulator nozzle to cut into the regulator seat the depth of one thread.

IF A SQUEALING NOISE COMES FROM REGULATOR WHEN PRESSURE DIAL ON HEAD OF MACHINE IS TURNED HIGH, THAT IS, WHEN A LARGE AMOUNT OF GAS IS FLOWING - You can quickly find out which regulator is squealing by leaving the gas flow at about 10 mm. Lift the Oxygen percent mixing dial slightly and swing it to 100. If the machine squeals in this position it is the Oxygen regulator. Turn Oxygen Percent dial to "0". If the machine squeals in this position it is the Nitrous Oxide regulator that is making a noise.

Remove the regulator from the machine. Unscrew the wing screw (2226). Release the small set screw that binds the threads on regulator bell (2220A). Unscrew regulator bell from regulator. If this doesn't come off easily, wrap an old rubber glove around the bell to give you a better grip. If it still won't unscrew, put two (2221) nuts against each other and remove the bell by applying a wrench to inside nut.

After removing the bell simply turn the spring (2210) over and replace. This will usually eliminate the squeal. If it doesn't, return regulator to factory for repair.

IF NO GASES FLOW FROM MACHINE UNTIL PRESSURE DIAL IS TURNED TO HIGH PRESSURE (10 mm OR ABOVE) AND THEN IT STARTS FLOWING WITH A BLAST - This condition is caused by a film of grease getting on the bottom of the check valve.

Unscrew mixing key cap (G-1000A2) with your fingers. If it doesn't remove easily, tap it with the handle of a screw driver. Reach inside the key and lift up the check valve disk. Clean the bottom of this disk, and the part the disk rests on

as well as the long stud screw guide pin, with ether, and replace.

TO CHECK FOR LEAKS IN ENTIRE HEAD OF MACHINE, BREATHING TUBES AND INHALER "Y" - Turn screw in inhaler body (#1475) in, tighten down on screw on top exhaling valve. Turn absorber control tightly to "CHANGE", or "OFF" on later machines as previously explained. Have all needle valves turned off. Turn pressure dial to about 10. You should hear the machine spurt a little and then shut off. If it doesn't, check all these connections on head of machine as follows:

Glass crystals over check valves.

Connection where flowmeter connects into machine head.

Top of flowmeters and bottom of flowmeter glass cylinder.

Hexagon nut that connects absorber to Nargraf head.

Hexagon nut that connects ether vaporizer to absorber.

A leak sometimes occurs under the glass disk in the mixing dial. To correct this, unscrew mixing valve key cap (G-100A2) and tighten gland nut (H-1076) which is on the inside of the cap.

Turn back rebreather valve to "ON". After the bag inflates, the machine should again cut off. If it doesn't, there is a hole in the bag or the bag connection isn't tight enough.

The inhaler body valve can be checked as follows:

When machine is turned on and the inhaler valve turned in, place soap suds over outlet of face body attachment. Watch for bubbles. To test this valve on the "ON" position, turn valve all the way out and with the hand firmly over the outlet of the face piece attachment, place soap suds over small port holes in front of the inhaler "Y".

TO SPECIFICALLY CHECK ABSORBER AND CANISTER COVER CONNECTION - Turn absorber control to "ON", turn back rebreather bag valve to "OFF". The inhaler body valve should still be "OFF". The bag should now inflate with the 10 mm pressure for which the machine is set. Turn the pressure dial "OFF" and watch the bag to see if it deflates. The bag can also be squeezed to exert still more pressure. You can now check for leaks where the absorber connector tightens against the absorber head. Note washer at this connection. Also examine the rebreathing bag to be sure it has not been punctured. Be sure the rebreathing bag is connected firmly to the canister cover.

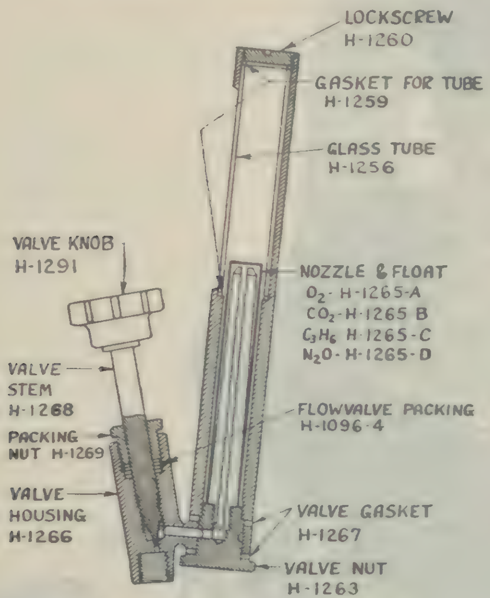
IF FLOWMETER FLOAT WILL NOT DROP TO BOTTOM OR JIGGLES INSTEAD OF STAYING STEADY AT A GIVEN FLOW RATE - Open flowmeter valve until float goes to top, then turn "OFF" again. If this does not correct the trouble, remove base of flowmeter (H-1263) and the whole float assembly will drop down. *Carefully lift the float* (H-1265) off the nozzle. Be very careful not to bend the float. Dip a cotton ended applicator in ether and swab out the inside of the float. Be *careful not to get any ether on the side of the float or it will take the paint off.*

IF THE MACHINE FLOWS FREELY WHEN PRESSURE DIAL IS SET AT "O" - In such a case replace rubber diaphragm (H-1020). You will probably find deep circles

cut into the old ones.

The check valve in the oxygen percent control should be examined to be sure no foreign particles are under the check valve.

FLOWMETER AND NEEDLE VALVE



Clean the brass nozzle with ether on a rag. Don't use any abrasive on this nozzle. Replace the assembly.

If two previous checks are made and gas is still flowing from the head outlet, check for leak in the direct oxygen valve as hereafter described. If necessary, replace direct oxygen valve seat.

IF HAND ON PRESSURE GAUGE WON'T RETURN TO "O" WHEN PRESSURE IS RELEASED WITH TANKS OFF - Remove glass crystal and take the indicator hand off axle by using two small screw drivers to force it off. Be careful not to let the hand fly away from you. Be sure *no* pressure is in the line. Put the hand back on the axle to register "O".

IF HAND ON REDUCED PRESSURE GAUGE REGISTERS ABOUT IN THE MIDDLE OF "OPERATING RANGE" BUT DROPS TO LOW SIDE WITH HIGH FLOW OF GAS - Be sure tank valve is well open.

Check wire mesh filters inside regulators.

Remove hexagon nut on right angle body (H-1017). Clean wire mesh filter with ether. Before replacing, blow a heavy blast of gas through the line to remove any foreign particles.

If trouble still exists check regulator seat. Note: In removing the absorber head from machine be sure to keep it tilted forward to prevent water under the check valves from flowing into the oxygen flowmeter. Should this happen the flowmeter must be taken apart and cleaned.

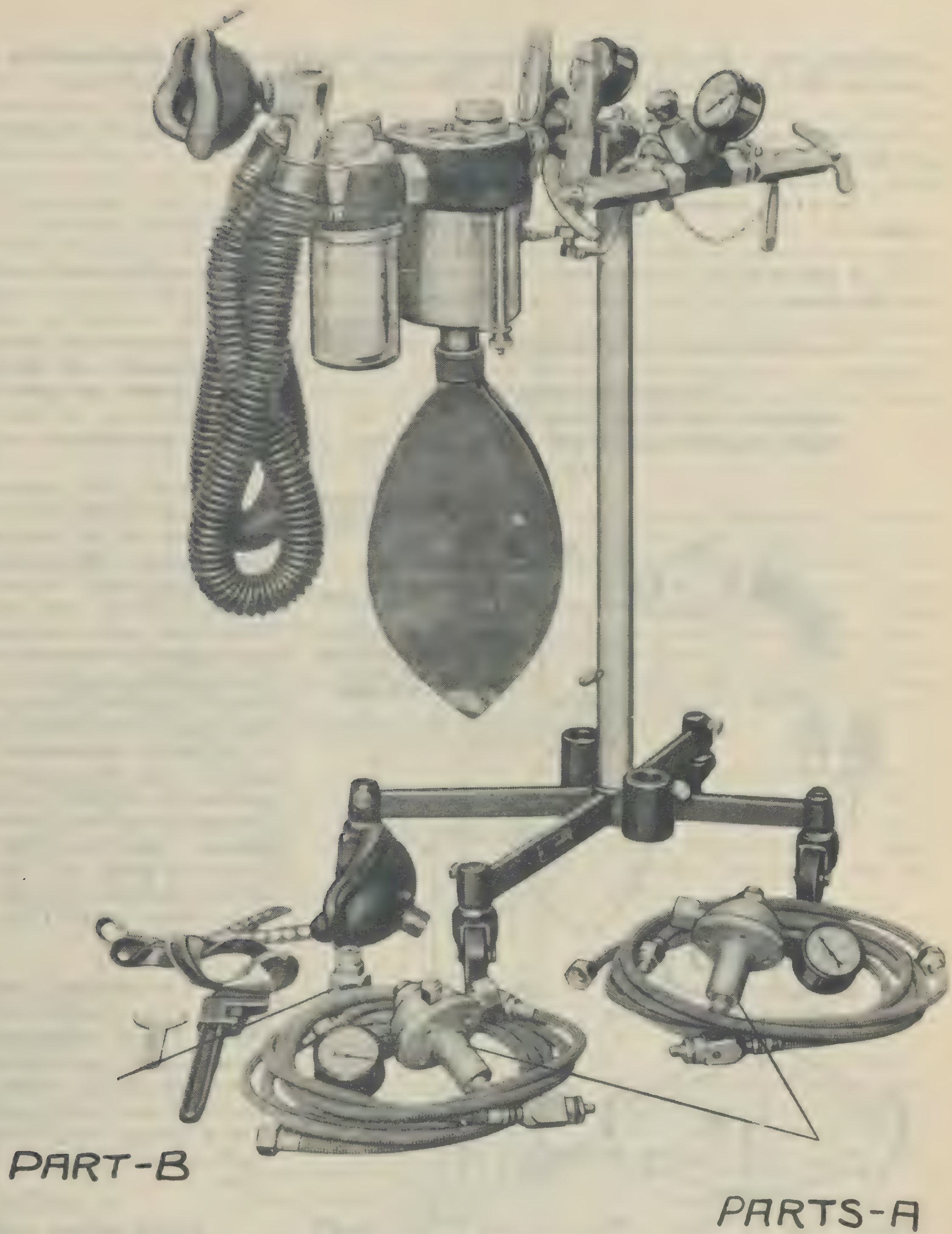
HOW TO STORE THE MACHINE - After washing the rubber goods, the large rebreathing bag should be replaced on the Soda Lime Canister cover to prevent air from getting to the Soda Lime when not in use. The Soda Lime absorber control should be in the "OFF" position.

McKESSON PORTABLE ANESTHESIA UNIT NO. 675

THIS UNIT CONSISTS OF - The head has 4 yokes for D size cylinders with tank pressure gauges and two flowmeters. Each flowmeter is operated by a separate needle valve control.

The front of the unit consists of a soda lime Absorber, Ether Vaporizer, breathing tubes, masks and a rebreathing bag. The Absorber is the circle type. Composition check valves, under glass covers, keep the gases going in one direction only. When Absorber control is turned full "ON", all of the exhalation goes through

VIEW OF McKESSON PORTABLE ANESTHESIA UNIT #675
NOTE UPPER TRAY (UNDER LID) IS FOR THE RUBBER PARTS, ETC. GAS MACHINE IS MOUNTED ON BOTTOM OF CASE. PART "A" IS LIFTED OFF OF PART "B".



VIEW OF McKESSON PORTABLE GAS ANESTHESIA APPARATUS #675 SET UP. NOTE REGULATORS (A) WITH HIGH PRESSURE TUBING AND END VALVES FOR USE OF LARGE CYLINDERS WITH THIS UNIT, ALSO ADAPTER (B) TO ADAPT OXYGEN REGULATOR TO COMMERCIAL OXYGEN CYLINDER

the Soda Lime. The check valves prevent "to and fro" breathing. One breathing tube carries *ONLY* the inhalation, while the other carries *ONLY* the exhalation.

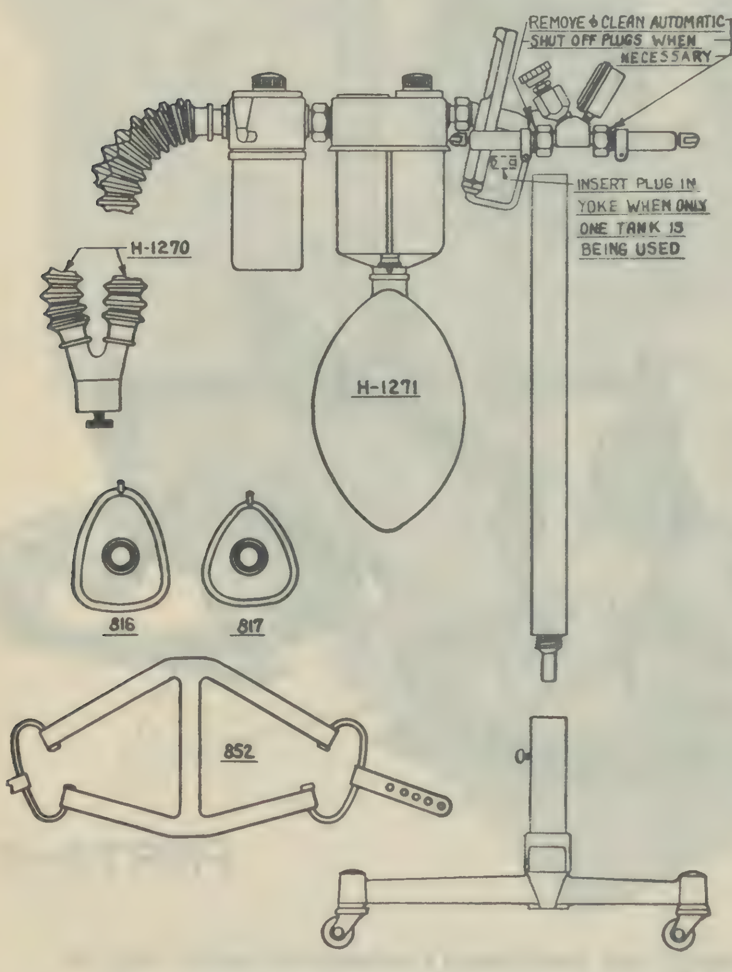
Oxygen and Nitrous Oxide regulators with tank pressure gauges for large F. M. or G. cylinders.

Two cloth covered regulator tubes with connections made up of 3 sections 4 feet each.

A mobile stand is provided. This stand is sectional and may be used in or out of the case.

A portable case is provided. This case has an upper section for carrying rubber goods and the sectional stand upright. The lower section of the case carries the bulk of the unit.

ASSEMBLY DIAGRAM
McKESSON PORTABLE ANESTHESIA UNIT IN CARRYING CASE MILITARY MODEL No. 675



Note: The gauges on the head of the unit are tank pressure or high pressure gauges. These register only when small tanks are being used in the yokes. When large tanks are adapted, a regulator with tank pressure gauge is attached directly to the large tank. The regulator tubing which is attached between the regulator and the yoke on the machine head carries only a reduced pressure of about 50 pounds, therefore, the tank pressure gauge on the head of the machine will not register when large tanks are used.

TO ASSEMBLE EQUIPMENT FOR SMALL CYLINDERS - Remove head assembly from support post in case--screw upright to stand base and replace head assembly and tighten wing screws to lock complete unit in position.

Attach rubber parts to apparatus.

In placing gas cylinders on unit be sure they are placed in their respective yokes. If it is desired to use stand out of case, loosen the four clamps that hold stand and place casters in position.

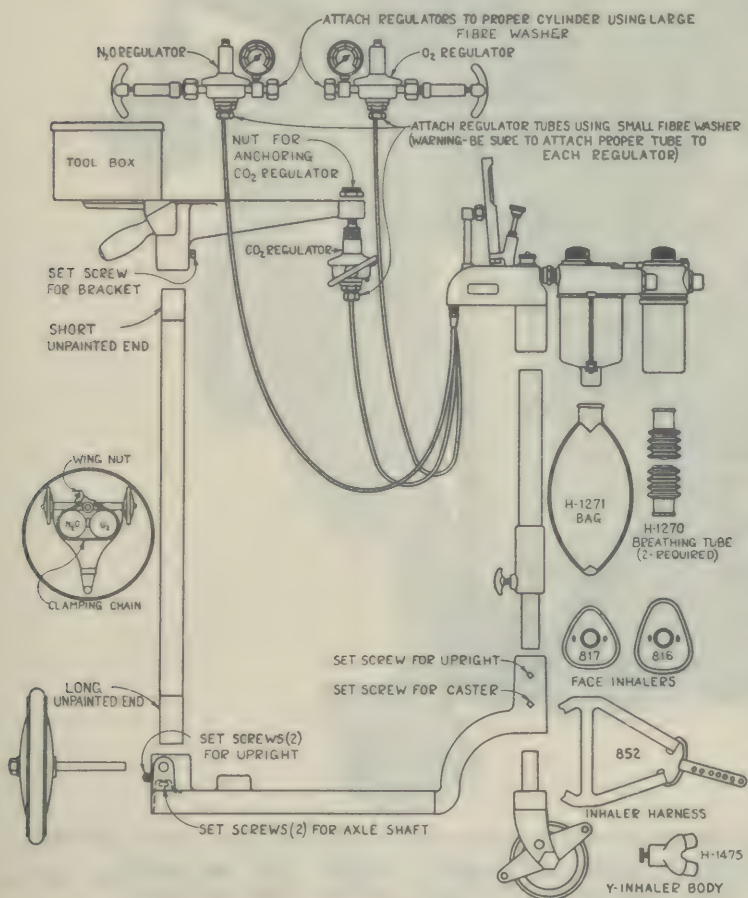
TO ASSEMBLE EQUIPMENT FOR LARGE CYLINDERS - Set up same as for small cylinders, then attach regulators to large cylinders using fibre washers in union nut connections (Note: If commercial oxygen cylinder is used, attach commercial adapter direct to cylinder valve and regulator to the adapter). Attach regulator tube to regulator using a fibre washer in union nut--place shut off valve on the other end of regulator tubing to proper small cylinder yoke on unit and clamp in place.

SERVICE SUGGESTIONS ON MILITARY MODEL #675 - Service problems that may be encountered with this apparatus will be essentially those covered previously on the Model "L" Nargraf and the #906 Truck Model machine. Note that the Portable Military Model has regulators with attached high pressure tubing and end valve for use of large cylinders. Service instructions on this regulator are covered specifically on the large truck model machine #906, since the regulators on these two units are identical. Note that they both have a pop-off valve on the regulator. Flowmeter, absorber and ether vaporizer repair is covered previously on the equipment mentioned.

MCKESSON LARGE TANK TRUCK HOSPITAL MODEL ANESTHESIA UNIT MILITARY MODEL NO. 906

This unit has a truck for carrying large F, M, or G size cylinders of Nitrous Oxide and Oxygen, a regulator and flowmeter for Carbon Dioxide. The Carbon Dioxide regulator has a yoke for small cylinders only. The Nitrous Oxide and Oxygen regulator have connections for both large and small cyliners.

McKESSON LARGE TANK TRUCK ANESTHESIA UNIT
MILITARY MODEL NO. 906



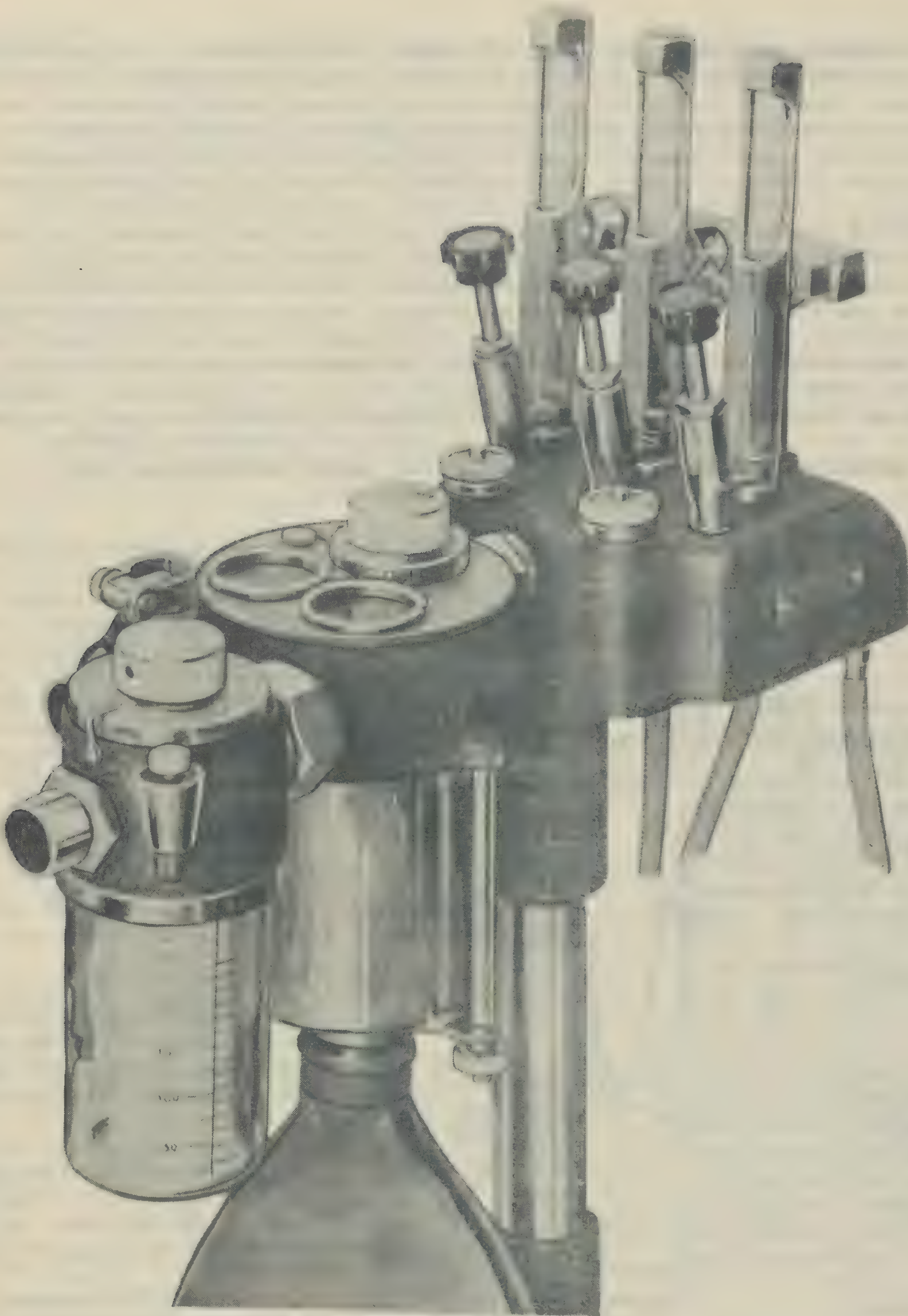
Although the appearance of this unit is quite different from the portable unit, the method of administering the gases are the same.

TO ASSEMBLE UNIT - After unpacking the unit carefully assemble the parts as indicated by diagram.

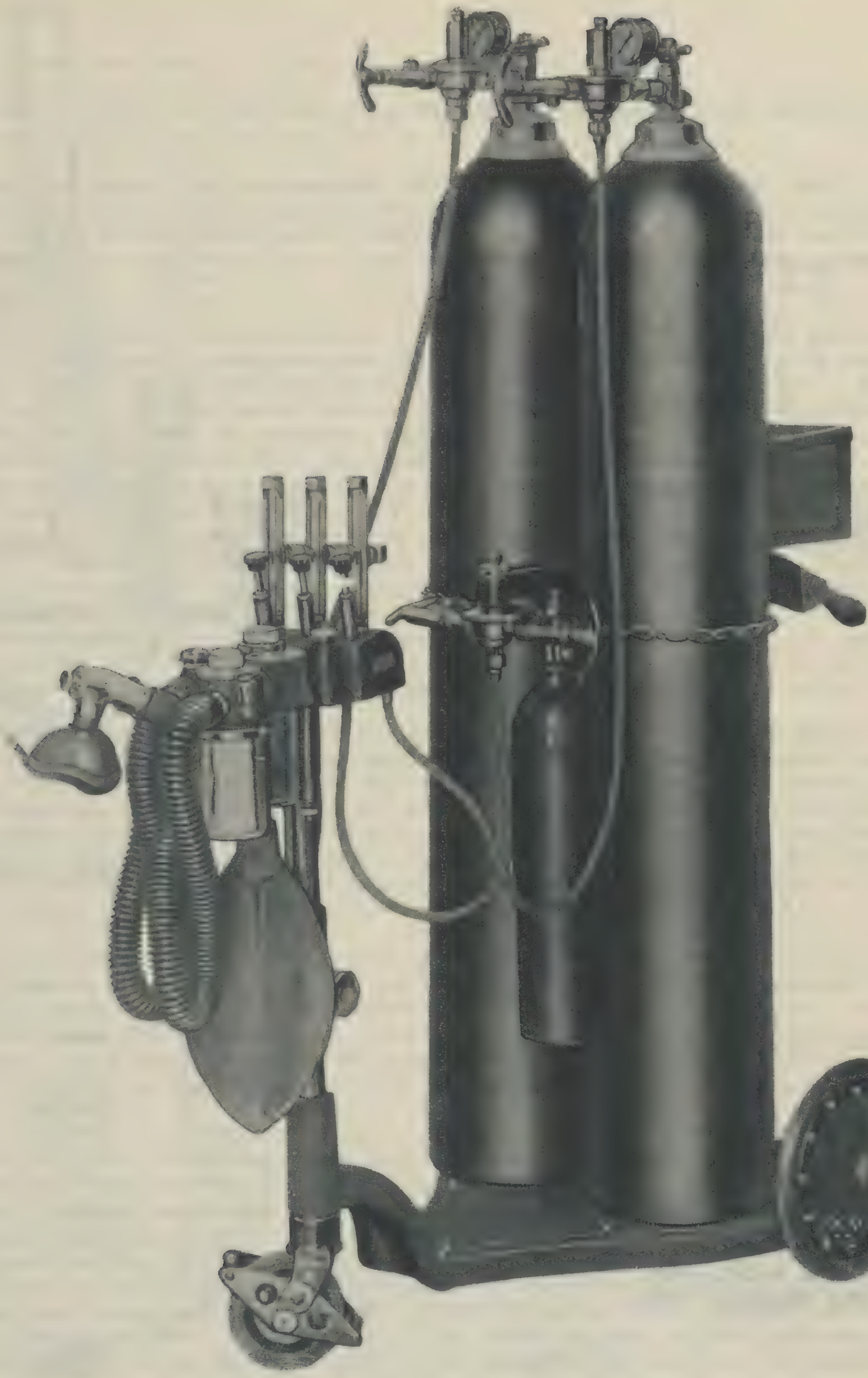
Place the large cylinders on the truck (as shown in circular inset diagram) and clamp in place by the chain and wing nut.

Regulators should now be attached to their respective cylinders using a large fibre washer in the union nut connection, and tightened securely.

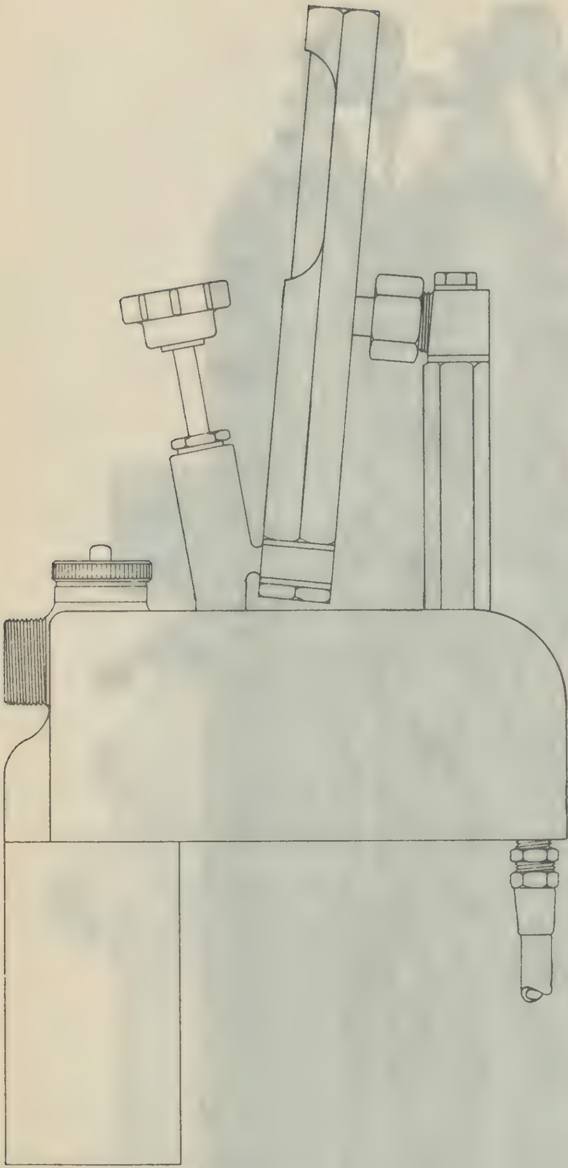
Be sure that regulators



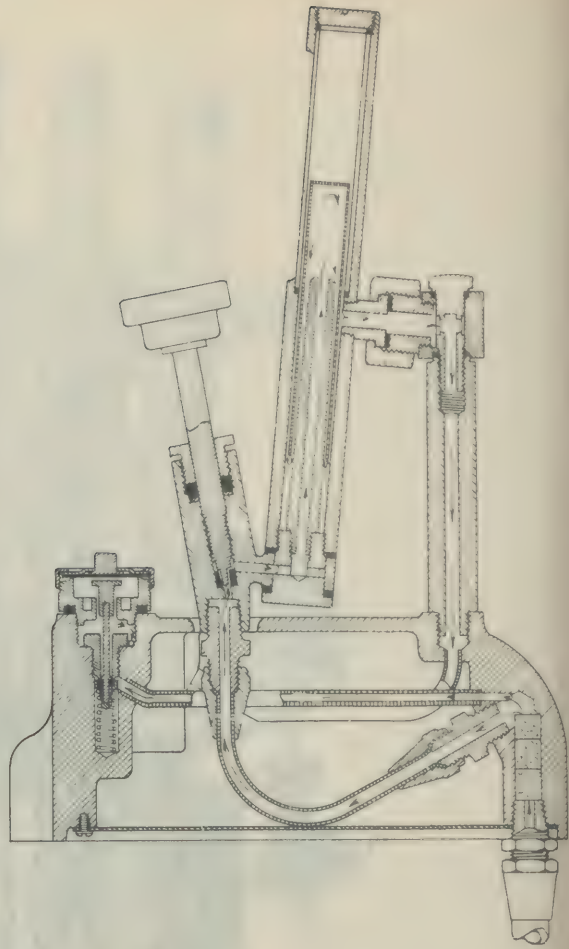
CLOSE VIEW OF THE FLOWMETER HEAD, ABSORBER AND ETHER JAR ON THE McKESSON #906 TRUCK (LARGE CYLINDER) MODEL GAS MACHINE. NOTE FLUSH BUTTONS FOR BOTH NITROUS OXIDE AND OXYGEN.



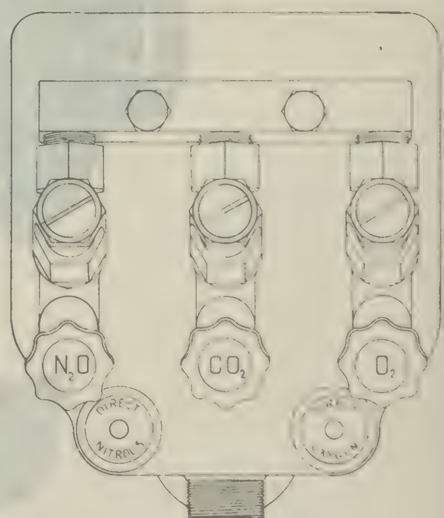
VIEW OF McKESSON #906 TRUCK (LARGE CYLINDER) MODEL GAS ANESTHESIA MACHINE SET UP WITH CYLINDERS, TUBINGS, ETC., FOR OPERATION



LATERAL VIEW



CROSS-SECTIONAL VIEW



TOP VIEW

VIEWS OF McKESSON MILITARY
TRUCK MODEL #906
GAS MACHINE HEAD

are attached to proper cylinder.

Place a small cylinder of carbon dioxide in the yoke of the carbon dioxide regulator and the unit is ready for use.

SERVICE SUGGESTIONS ON McKESSON ANESTHESIA UNIT MILITARY MODEL #906 - Checking for a leak with this large cylinder model machine is very similar to checking for a leak on the Heidbrink large cylinder gas machine. The only difference is that you do not have specific ports to check to localize a leak in the machine head itself.

With the needle valve closed if the needle on the high pressure gauge drops when the cylinder of a respective gas is turned off, this indicates a leak somewhere in that system. The first thing to do is to localize the leak--whether it is from the cylinder to the flow meter head--or in the head itself. To ascertain this, remove the absorber from the flowmeter head (just as you do with the Heidbrink). Put soap suds over the outlet from the flowmeter head. If bubbles develop there is a leak in the flowmeter head. Either the direct flow valve seat is not holding, or there is a leak by the needle valve. To check for a direct flow valve leak proceed as follows: Remove diaphragm covering nut (H-1027) from direct Oxygen with your fingers. Remove button plate (H-1029) Direct Oxygen (H-1004) rubber diaphragm, (H-1031) and outside plunger (H-1030). Use special T-handle wrench that has one pen on the end of it and remove emergency valve body (H-1026). Place soap suds around stem. Should bubbies develop, the valve seat is faulty. To replace, use new valve seat following instructions covering this valve given on the Model "L" Nargraf. Use identical procedure in testing the Direct nitrous oxide valve.

The other source of leak in the head other than the Direct Valve may be a faulty needle valve. If the needle valve is inefficient to any degree the flowmeter float will remain "UP" in spite of the respective needle valve being closed. However, there may be a small leak by the needle valve which might not be indicated by the flowmeter float and this may be detected by testing the outlet of the flowmeter head after making sure that the direct valves are not leaking. Soap suds over the outlet of the head of the machine should show whether or not gas is getting by the needle valve. If needle valve is inefficient, replace with new assembly.

If leak was found to be between the head of the machine and the cylinder, locate leak by using soap suds from cylinder to connection of high pressure tubing at the flowmeter head up to the cylinder. This will include, of course, the high pressure tubing and the regulator. Note that the regulator on this model has pop-off valve. This model does not have reduced pressure gauges. A deficient main seat on the regulator of this machine will be evidenced by the escape of gas through the pop-off valve.

The main seat is removed and replaced exactly as described in the directions given on the Model "L" Nargraf. Other repairs to this regulator are also covered. The only thing not mentioned previously in repair of this regulator is the service to the pop-off valve itself. This rarely needs attention, however, if gas is escaping from this valve after the main seat has been replaced properly, this indicates that the seat in the pop-off valve itself is not holding. Loosen the lock nut slightly and remove set screw and the spring behind the seat. Remove and inspect the pop-off valve seat. Make sure that the facing is O.K. before replacing. Replace set serew to the exact position in the valve as indicated by the position of the lock nut on the thread. On admitting gas into the regulator, if this valve still does not hold, turn in further on the set screw until no gas gets by.

Continual loss of pressure from the rebreathing bag during anesthesia indicates that pressure is being lost between the needle valve and the face Inhaler "Y". With the face inhaler valve turned inward thus closing off the rebreather tubes, fill the entire absorber system with gas. Exerting pressure on the rebreather bag, test the following points for leaks:

Flowmeter tube gasket (see both the top and bottom of the flowmeter glass tube).

Test absorber to flowmeter head connection. There should be a washer at this union.

Check all connections on the absorber including around the flutter valve housing glass crystals.

Test absorber canister cover connection.

Rebreathing bag and rebreathing bag connection to canister cover.

Rebreathing tube connections to ether jar and absorber.

Ether jar connection to absorber head.

Face inhaler valve in the open position, that is, turned all the way out.

To test the front facing of this valve, hold hand of face inhaler outlet attachment and put soap suds over ports and the front of the inhaler "Y". If bubbles develop, the front facing of this valve is not efficient. The valve is in this position during anesthesia, therefore, should be checked in this manner.

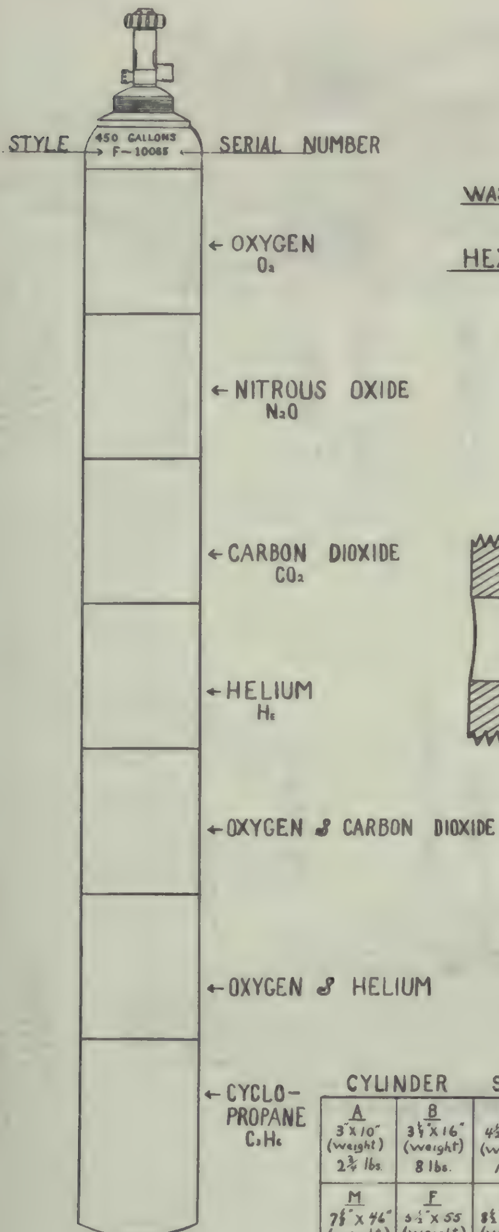
If there appears to be any obstruction to the flow of the gas after it leaves the regulator, check filters above the point where the high pressure tubing attaches to the head of the machine.

REGULATOR CHECK VALVE REPAIR (CLEANING) INSTRUCTIONS - Take tension off wingscrew. Remove bell cap. Remove tank pressure gauge. This exposes a steel ball check valve. Remove and clean with carbon tetrachloride. Blast with tank pressure. Replace check valve. Shellac threads of tank pressure gauge and replace.

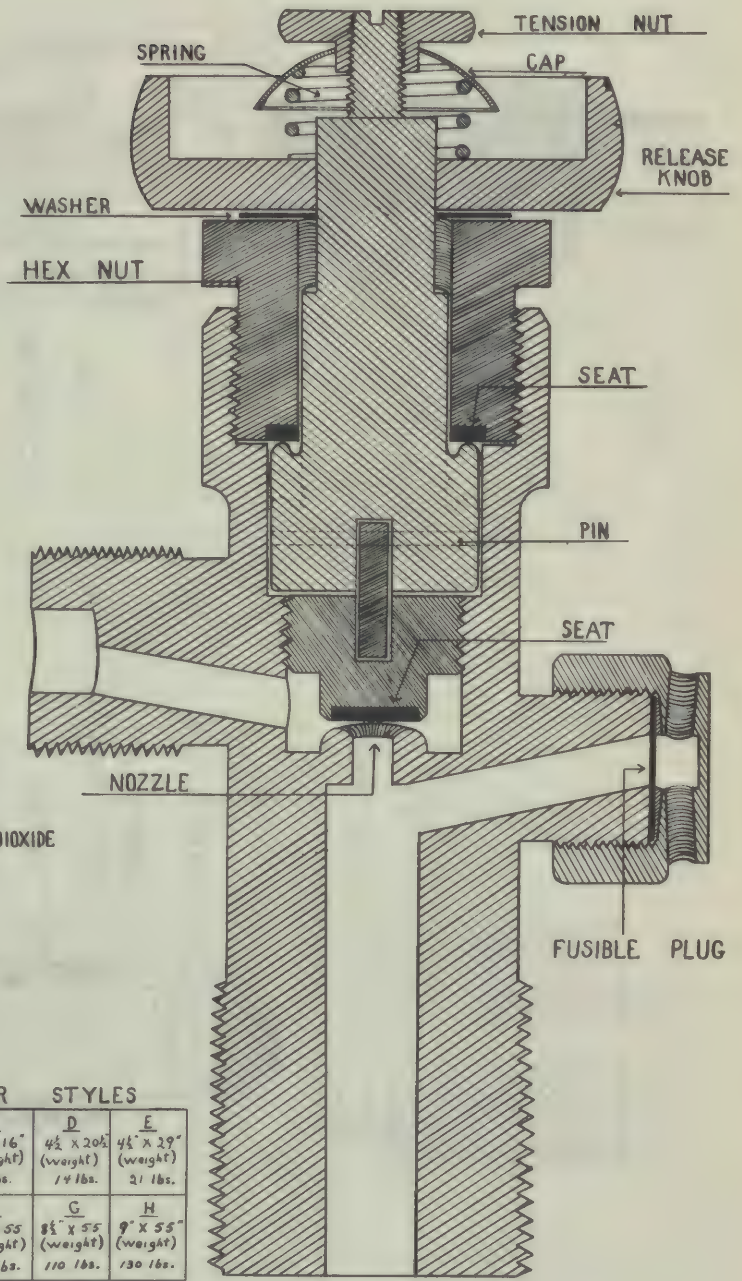
FLOWMETER REPAIR - The flowmeter should be removed carefully since there is very little clearance at the bottom. Unscrew valve nut #1263, slightly. Now loosen the nut at the back of the flowmeter completely. On unscrewing the valve nut at the bottom of the flowmeter, the flowmeter housing should be lifted straight up. This exposes the float and nozzle. Clean flowmeter as previously instructed.

ABSORBER HEAD - If soda lime canister cover appears stuck to absorber gasket use a finger nail file or similar instrument, and force it between the canister gasket and carefully free the canister from the gasket. Go all around the canister rim before trying to pull it away from the gasket. Clean canister brim and gasket with carbon tetrachloride.

CYLINDER & COLOR SCHEME



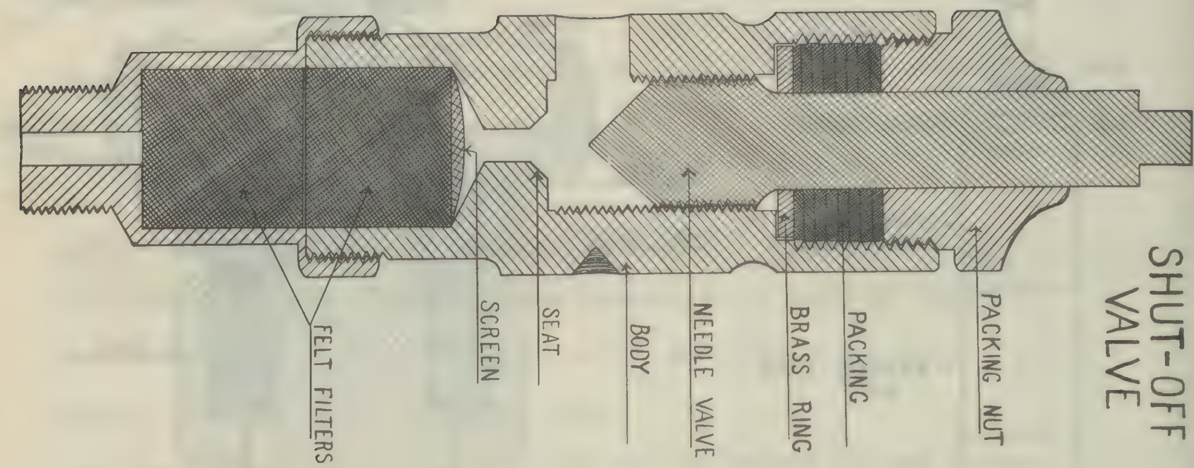
LARGE CYLINDER VALVE

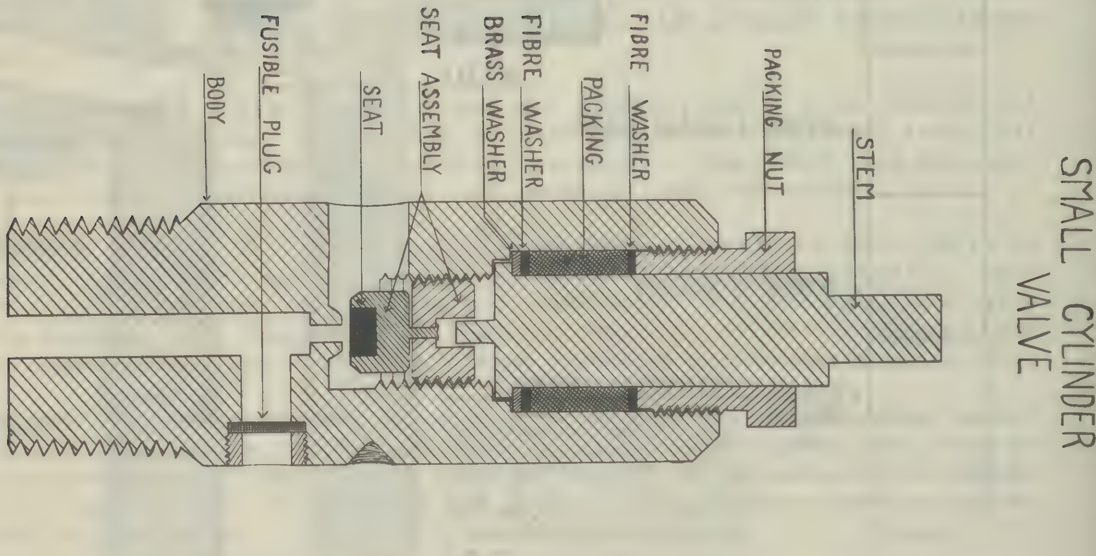


CYLINDER STYLES

A 3" x 10" (weight) 2¾ lbs.	B 3½" x 16" (weight) 8 lbs.	D 4¼" x 20½" (weight) 14 lbs.	E 4¼" x 29" (weight) 21 lbs.
M 7⅛" x 46" (weight) 70 lbs.	F 5½" x 55 (weight) 70 lbs.	G 8½" x 55 (weight) 110 lbs.	H 9" x 55" (weight) 130 lbs.

SMALL CYLINDERS "A" to "E", LARGE CYLINDERS "M" to "H".


SHUT-OFF VALVE
PACKING NUT
PACKING
BRASS RING
NEEDLE VALVE
BODY
SEAT
SCREEN
FELT FILTERS


SMALL CYLINDER VALVE
STEM
PACKING NUT
FIBRE WASHER
PACKING
FIBRE WASHER
BRASS WASHER
SEAT ASSEMBLY
SEAT
FUSIBLE PLUG
BODY

CHAPTER V

OXYGEN THERAPY

DEFINITION - Treatment with oxygen for existent body oxygen insufficiency.

METHODS OF ADMINISTERING OXYGEN THERAPY:

1. Oxygen tent.
2. B. L. B. masks.
3. Nasal catheter or tubes.
4. Oxygen chamber.
5. Circuit type unit.

CONDITIONS TREATED WITH OXYGEN THERAPY:

1. Heart Disease.
2. Pneumonia and pulmonary edema.
3. Anoxemia states.
4. Gas poisonings.
5. Asthma - (Helium and Oxygen mixture used).

OXYGEN THERAPY TO BE EFFICIENT AND ECONOMICAL MUST MEET THE FOLLOWING REQUIREMENTS:

1. Oxygen meeting U.S.P. specifications.
2. Safe, efficient operating apparatus.
3. Anyone assigned should know proper setting up of apparatus and its operation, making sure it is accomplishing its purpose to the fullest extent.

McKESSON OXYGEN TENT #410 A

INSTRUCTIONS FOR ASSEMBLING McKESSON HOSPITAL MODEL OXYGEN TENT NO. 410-A - Unpack carefully and save all the packing material until the tent is fully assembled in order not to throw away any parts.

Tent is shipped in two cartons, one containing the tent proper, and the other one the canopy, support tubes, tent crane and water drain box. Double elbow with the two large corrugated tubes attached are sometimes packed in the ice chamber.

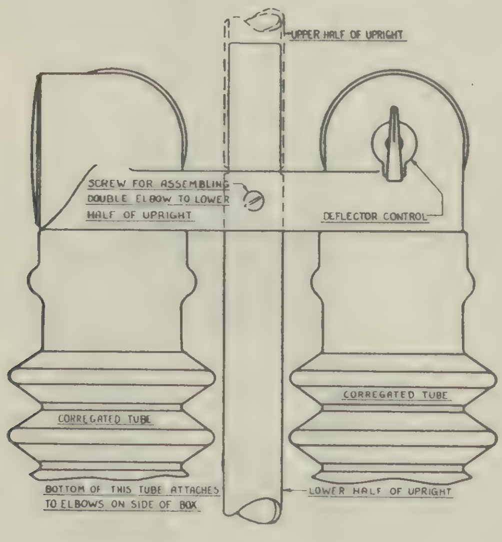
After all the parts have been unpacked carefully, assemble double elbow casting carrying corrugated tubes to support by means of screw provided in lower half of upright (see cut). Then place this assembly, the lower half of the tent support, in bracket on side of ice chamber between the two lower elbows and tighten set screw. Then connect corrugated rubber tubes to lower elbows. Place the upper half of this crane over slip joint connection just above upper elbows.

The three spring spreaders, which support the tent, are now placed over the horizontal section of the crane angle at the top of the crane upright, then the four loops attached to the four top corners of the tent are placed on the hooks at the end of the spring spreaders.

The smaller chrome plated tube with the three collars is now placed in the angle at top of the crane upright and locked in place by the wing screw.

The spring spreaders carrying the tent may now be placed in the collars provided. The two flexible rubber connections used to connect the tent to the cooling unit should be connected.

To assemble shelf, when provided, push shelf support rod through rubber grommet and into support bracket as far as it will go and tighten wing nut on support bracket.



This assembly will not be necessary if unit is not equipped with deflector and damper control.

The fabric covered regulator tube should now be attached to the pressure reducing regulator, using a fibre washer provided to make the connection gas tight.

To fold tent for transportation. The spring tent spreaders should be lifted out of their collar on the horizontal section of their crane and placed over the wing screw on the angle bracket of the crane upright, also the loops at the bottom of tent skirt should be hooked to the spring spreader.

The horizontal section of the crane may now be removed and placed on the hook provided on horizontal section of crane upright.

The regulator may now be placed in the bracket on the side of the cabinet and the unit is collapsed ready to be transported.

INSTRUCTIONS FOR OPERATING McKESSON HOSPITAL MODEL OXYGEN TENT NO. 410-A - After assembling the apparatus, as previously directed being particular to see that all connections from the oxygen tank to the cabinet are securely tightened to prevent leakage, proceed as follows:

1. Completely fill the ice box with cracked ice, the size of ones fist. Ice door is removed by turning bakelite knob to the left to loosen, then lift up. After ice chamber is filled, replace ice door and turn knob to right until it stops.

2. Connect the regulator to the oxygen tank, using the adaptor, if employing commercial oxygen, and making sure that there is a suitable washer in the connection between the regulator and the adaptor. Tighten securely.

3. If unit is equipped with a soda lime absorber remove sodalime door in the manner used to remove ice door. (Soda lime door is the small one) then remove soda lime basket and fill with soda lime and replace. Soda lime control on front panel determines the portion of gasses that pour through the absorber.

4. Attach electric line to lighting or power fixture (110-volt, 60 cycle A. C., or 110 volt. 25-60 cycle or 110 volt D. C., as marked on tag on lead cord) and snap switch "on" and turn rheostat control toward "cool" to see that blower operates correctly.

5. Now open oxygen valve. (Always keep a full tank of oxygen ready for substitution but especially after the tank pressure gauge on the regulator registers five hundred pounds or less.)

6. Before applying the tent to the bed, place a rubber sheet under the patient with the bed sheet or bed sheet and blanket between the patient and the rubber sheet. The purpose of the rubber sheet is to prevent oxygen from passing through the mattress and escaping from the tent. Check the oxygen analyzing valve in the exhaust tube from the tent to see that it is turned off. Now bring the tent over the bed and adjust the height until the lower edge of the windows almost touch the bedding over the patient. If a hospital bed is used, carefully tuck the skirt of the tent under the mattress of the head and along the sides, and if possible, tuck the flap that extends in front over the patient, under his hips. If a wide bed is used, tuck the tent around the patient, as much as possible. Leave some of the bed covers under the tent, but also have the spread or at least a part of the covers over that portion of the tent that lies across the patient. The more precautions that are taken in making the application to the bed and patient the greater concentration of oxygen may be obtained with a given flow rate. Give enough oxygen, but don't waste it unnecessarily.

7. Charge the tent with oxygen as follows: Give the flow meter valve, one full turn to the left and let the oxygen flow for five minutes. If the tent has been properly applied, this will give a concentration of approximately 50% oxygen in the tent. If possible, check the concentration of oxygen in the tent by gas analysis. Then set the flow meter for from four to eight liters per minute. When opening the tent to give medicines or food, also when icing, shut off the motor, so that the oxygen is not blown out of the tent. Avoid opening the tent frequently, as much oxygen is lost by so doing.

If the patient needs high concentrations of oxygen, increase the flow rate and

keep the tent closed as much as possible.

Hang water container under cabinet and keep ice box drain open to let the water out, while in use. The drain is water-sealed, so that no oxygen escapes at this point. To clean drain remove hexagonal nut on shut-off valve.

8. Damper in elbow on cabinet, if provided, which controls ventilation should normally be set at the open position and the *temperature in the tent controlled by the motor rheostat* on front panel.

Only in very rare occasions will it ever be necessary to close this damper valve, so be sure it is always in the open position for normal operation.

9. Now adjust the temperature control rheostat until the circulation of oxygenaged air through the ice chamber is just fast enough to keep the tent temperature comfortable for the patient. The motor now runs slowly with very little noise. Run the motor as slowly as possible to maintain the temperature desired. If the tent becomes warm, check the ice to see that the ice chamber is filled. The room should be kept warm, not cold, when using a tent.

Remove lint from screen in intake tube to tent, daily if necessary. Screen must be kept free from lint to insure proper circulation.

10. Oil motor once each season with high grade motor lubricant.

11. When a patient has been in the tent continously for several days, do not remove the tent permanently at once, but "taper off" the treatment by re-applying the tent several times for an hour or so. Double the intervals of time that the tent is left off the patient in much the same method as one decompresses a diver.

12. Owing to the escape of oxygen due to poor applications of tent to the bed, and the necessary opening of the tent for food and medicine, there is but one sure method of knowing the oxygen concentration and the quantity of CO_2 present and that is by gas analysis, the equipment and technic of which is quite simple and fully described with the analyzer No. 380. It is often possible to maintain oxygen concentrations of 50% to 60% with as little as two liters flow per minute, but is not safe to run it that low unless you know by analysis that the desired concentration is actually maintained. Then, too, with very low flow rates of oxygen, CO_2 tends to accumulate above ½% concentrations which may or may not be desirable in a case. The proper use of gas analysis pays over and over by saving oxygen and also in assuring adequate treatment. A careful record of the oxygen treatment should be kept for future reference and as an aid to prognosis.

To fold tent for transportation. The spring tent spreaders should be lifted out of their collars on the horizontal section of the crane and placed over the wing screw on the angle of the crane upright, also the loops at the bottom of tent skirt should be hooked to the spring spreader.

The horizontal section of the crane may now be removed and hung on hook provided in angle of the vertical crane support.

If it is desired to remove the canopy from the unit, loosen the wing screw which holds the shelf in position and remove shelf by pulling off into the canopy. Reverse the procedure to replace tent on unit. This applies to units equipped with shelf.

The regulator may now be placed in the bracket of the cabinet and the unit is

collapsed ready to be transported.

SERVICE SUGGESTIONS FOR OXYGEN TENT

IF TENT DOES NOT COOL PROPERLY - If difficulty is experienced in maintaining low temperatures in the tent one of the following is probably the reason for it not functioning properly: 1. Lint from the bedding on screen of outlet from tent canopy; 2. Motor operated at too slow a speed; 3. Failure of electrical current or motor; 4. More ice needed in ice chamber; 5. Check soda lime container if soda lime is used, to see that this material is not caked, or that the mesh of the lime is so small that it will not allow free circulation. 6. If unit is equipped with damper see if it is in proper position.

The guide to the proper temperature in the tent is the thermometer which indicates tent temperature and the comfort of the patient.

Pay particular attention to item 1, above, as it is surprising how quickly lint will accumulate on the screen.

HOW TO OIL MOTOR - Remove the small front panel on ice chamber held in position by two small thumb screws. Oil motor at two points. A few drops are all that is necessary.

IF MOTOR DOES NOT OPERATE - Check to see that unit is attached to proper current. See that the speed control is turned to the right as far as it will go. If tent is equipped with universal motor, check brushes to see that they are contacting armature properly.

ORDERING PARTS FOR TENTS - In ordering parts for tents be sure to give the serial number, and model number, and if canopy is desired check canopy for part number. When ordering motor parts be sure to give make, model and serial number of motor in unit.

HEIDBRINK #57 MOTORIZED TENT

OPERATION #57 TENT - Circulation in this tent is accomplished by a universal type motor fan, 110 volts, A.C. or D.C. current. In setting up this apparatus care should be taken in attaching the flexible rubber tubings from the regulator to the tent cabinet. Make sure that the tubing attached to the outlet of the flush valve on the regulator is attached to the inlet that opens directly into the ice chest. Make sure that the other flexible tube that is attached to the outlet of the needle valve on the regulator is connected on the bottom of the flowmeter on the tent cabinet.

Be sure that fresh soda lime is in the soda lime basket. The lime should be good for 15-20 hours of usage. This lime basket is removed through the side of the tent cabinet. Have ice chest filled to the lower margin of the tent inlet with pieces of ice the size of the fist. Pressure gauge on the regulator indicates cylinder pressure. Be sure cabinet cover is on securely. Note drain cup covering cabinet drain. Fill this about half full of water. Be sure drip pan is in place. Oxygen flow to the patient is set by a mechanically controlled needle valve just below the regulator body.

Flow rates are indicated by a flowmeter located on the tent cabinet. Flush valve located on the regulator is for building up quick concentration of oxygen in the hood.

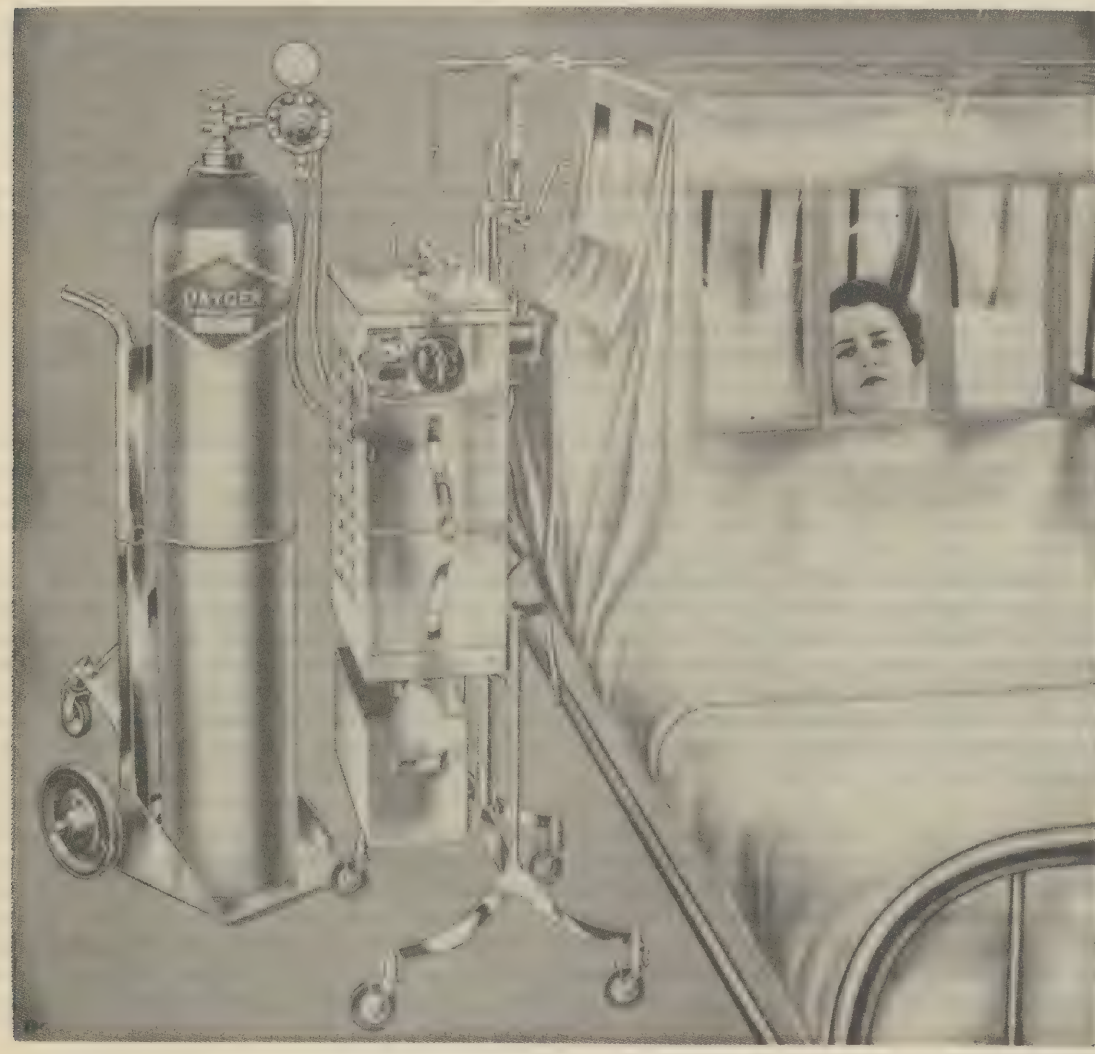
At the tent inlet there is an adjustable deflector which provides a means of

directing circulation so as to prevent a direct flow on the patient.

At the tent outlet there is a thermometer which indicates tent canopy temperature.

A gas analysis apparatus is provided with this tent (Ohio Chemical and Manufacturing Company type).

A curved metal tube on the top right margin of the tent canopy allows for removal as sample of the tent air for analysis. Note there is a rubber cap on this tube outlet. Be sure this cap is replaced after taking a sample.



HEIDBRINK NO. 57 MOTORIZED OXYGEN TENT

HEIDBRINK NO. 57 MOTORIZED OXYGEN TENT
TEST AND REPAIR DIRECTIONS

NO. 1. TO TEST TANK REGULATOR FOR LEAKAGE:

a. Open the oxygen tank and turn control knob on regulator valve to set the liter gauge beneath at "6".

With shaving brush or equal apply soap film as follows and observe if bubbles form:

b. Around the regulator valve cap-nut.
c. Over the holes, base and top of the safety valve.
d. Over the holes in top of the bell cap and completely around the edge of the bell cap where it screws onto the regulator castings. Any bubbles here indicate leakage past the diaphragm.
e. Around union nut which attaches hose which leads to the ice box.
f. On the gauge studs where the gauge screw in to the castings.

NO. 2. TO REPAIR TANK REGULATOR VALVE, SAFETY VALVE AND DIAPHRAGM - Defects in the safety valves are rare. More often when leakage discharges through the safety valve it is the regulator valve that leaks and builds up pressure underneath the diaphragm beyond that at which the safety valve is set, and the safety valve opens normally to release the pressure. Therefore before disturbing the safety valve, first replace the regulator valve with a new one as follows:

a. Start with clean hands. Any oil on the valve will ignite in the presence of oxygen under pressure.
b. Remove the hexagon cap nut, and remove the spring and valve.
c. Open a tank to blow out debris.
d. Wipe out the valve chamber with a clean lintless cloth.
e. Replace the parts supplying a new valve.
f. Tighten the cap nut firmly to seat.
g. Test the safety valve and if it leaks screw off the knurled valve casing with the fingers. Carefully loosen with pliers if necessary.
h. Clean off the valve seat, or preferably replace with a new one. Do not disturb the screw adjustment at the outer end of the sleeve.
i. Again test.
j. If adjustment appears necessary loosen lock nut on adjustment screw and gradually tighten and test until leakage stops.

NO. 3. REGULATOR DIAPHRAGM - To replace regulator diaphragm with a new one.

a. Screw off the regulator bell cap and remove the diaphragm. If damaged put on a new one.
b. Paint a thin film of Q-Seal on the surface near the outer edge of the diaphragm where it contacts the diaphragm seat on the regulator casting. The diaphragm seat should be wiped clean.
c. Screw on the regulator bell and tighten firmly to place.

NO. 4. TO CLEAN AND REPAIR FLOWMETER - To remove the flowmeter from the machine head:

a. Remove (screw out) needle valve.
b. Slightly loosen the hex union nut which attaches to the bottom of flowmeter tube.
c. Screw out the hex bolt which attaches the flowmeter to the tank manfold.

d. Screw off the nut first loosened.

To remove the float indicator the hands should be clean and dry.

e. Invert the flowmeter and with a knife or screwdriver carefully remove the retaining ring positioned inside of the very end of the tube.
f. Place the palm of one hand over the end of the tube while turning the gauge right end up. Carefully lift the gauge slowly and let the indicator float drop out in the hand.
g. Handle float gently and wipe it off with a clean lintless cloth. Avoid unnecessary handling.
h. The glass tube of the flowmeter can be wiped with an ordinary pipe cleaner which can afterwards be bent double for wiping the inside wall of the tapered flow tube. Avoid using any material which would leave lint or fragments within the tube.
Never blow the breath into the tube as moisture will be precipitated and might interfere with free action of the float.

To replace the float:

i. Invert the flowmeter and drop the float stem downward into the tube. If the stem does not immediately find the opening into the glass tube the float will protrude. Do not press on the flowmeter float as it cannot be shoved into place. Simply shake the gauge gently until the float stem drops to place.
j. Replace the float retention-ring and reassemble on the machine.
k. Should the float be at all damaged, replace with a new one.

NO. 5 TO REPLACE BEVEL GEARS ON ELEVATING SCREW

a. Remove spun brass housing from top of the center upright post. Beveled gear wheels will be exposed.
b. Hold first nut directly under beveled gear with a wrench and loosen nut at top of stem. Then loosen nut directly thereunder.
c. Apply a wrench to each of the nuts at the top of stem and lock them tightly together.
d. Hold the lower of the two nuts at top of stem with a wrench and loosen the second nut located below beveled gear. Then unlock the two nuts above the gear and remove them.
e. Screw off beveled gear.
f. The other bevel gear wheel is anchored to the crank shaft by a tapered pin, the larger end of which is up when the crank handle is in down position. Therefore to remove the gear wheel raise the crank handle up and drive out the pin.
g. If gear wheels are damaged replace with new one.

Re-assemble as follows:

h. Before putting on the smaller gear wheel insert the tapered lock pin to see on which side of the gear shank is the large end of the tapered hole. Mount the wheel with this side up and the crank handle down and drive in the pin.
i. Screw on other gear wheel down to completely mesh with pinned on gear wheel but not to bind unduly. Lock nuts beneath up snugly to it.

NO. 6 MOTOR AND RHEOSTAT - The motor and rheostat are designed to operate on

110 volts to 120 volts, either direct or alternating current.

The motor is completely enclosed; its bearings are lubricated with sealed in grease. No oiling is needed.

Motor brushes will wear with use and should be examined at nine months to one year intervals. To replace them with new ones.

a. Remove the panel held by four screws from the motor chamber of ice box and screw off the brush caps from the motor.

The rhoestat if attached to 220 volt current will burn out. It cannot be repaired. To replace with new ones.

b. Screw out the two attachment screws and disconnect the two electric wires.

HEIDBRINK COMBINATION TYPE OXYGEN TENT
MODEL NO. 75

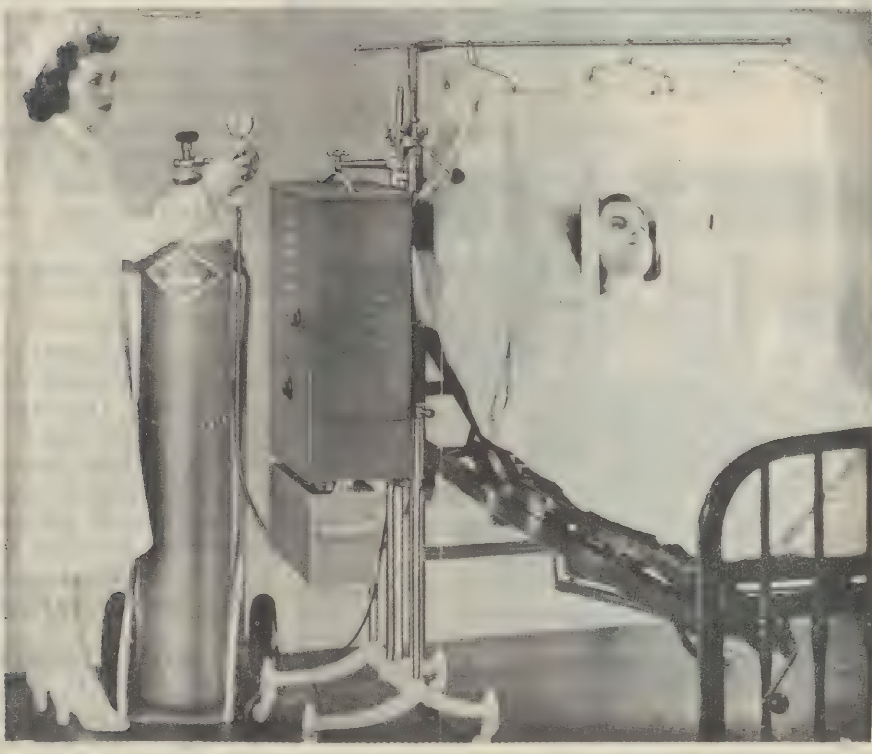


ILLUSTRATION NO. 1

OPERATION - The Heidbrink #75 combines the features of the motor and injector types of tent in one unit. The operator may use either the injector or the motor blower individually, or may combine both to provide greater circulation and cooling.

Illustration #2

Illustration #3

For injector operation of the Model #75, the operator merely sets the desired rate of flow (Illustration No. 1) on the injector gauge of the automatic tank pressure regulator and the Oxygen begins flowing through the injector into the ice compartment and then to the tent hood. Using water ice the injector is designed to maintain adequate cooling under usual conditions. An adjustable by-pass valve with dial permits directing all or any part of the circulating Oxygen by and away from the ice, thus completely controlling the cooling. Adequate circulation for the patient's comfort and for removal of Carbon Dioxide from the tent air may therefore be maintained without subjecting the patient to undue cold. If more Oxygen is required without increasing circulation, the additional amounts are added by opening the Oxygen flowmeter valve on the ice chest (Illustration No. 2). If extreme climatic conditions or the patient's comfort appear to demand greater circulation, the operator may then turn on the motor-blower and adjust the speed until requirements are met. A flush valve located adjacent to the flowmeter permits building up of concentrations without affecting the set rate of flow.

Desired temperature within the hood is obtained and can thereafter be maintained as set. Tent-air temperature is indicated by an armored thermometer mounted in the opening from hood to soda lime chamber. The tent-hood support arm is hinged, and may be tilted upward and held in such position by a chain and hook which attaches to the handle of the ice chest until the hood is properly positioned over the bed. No assistant is needed to lift the hood skirt over the patient.

The chest and canopy can be lowered and the tent arm folded for transportation to the patient's bedside. Adjustment to bed height is afforded by an elevating mechanism (Illustration No. 3). When not in use or when the tent is being transported, the handle folds back out of the way.

The ice compartment is designed to hold sufficient ice so that refilling is minimized.

The ice chest is equipped with drain with removal trap which catches and holds the drip during the brief interval needed to empty the drain pail. The drain pail has a drip silencer.

A soda lime compartment provides for the removal of excess Carbon Dioxide from the tent atmosphere. The motor is of the fully enclosed, universal type which operates on either alternating or direct current and is equipped with a sealed lubricating system. A mercury switch and enclosed rheostat provide control of motor speeds.

Two styles of hood are available, the "Regular", of rubberized fabric with large, transparent, non-inflammable windows all around and provided with zippered openings to permit insertion of food, liquids, etc., and the "Clear View", of transparent, non-inflammable plastocele. Both hoods are full hospital bed width, and are suspended on spring hangers which relieve unnecessary strain on hood material.

TEST AND REPAIR DIRECTIONS
(Operates with or without electricity)

NO. 1. TO TEST TANK REGULATOR FOR LEAKAGE:

a. Open the oxygen tank control knob on regulator valve to set the liter gauge beneath at "6".

With shaving brush or equal apply soap film as follows and observe if bubbles form:

b. Around the regulator valve-cap-nut.
c. Over the holes, base and top of the safety valve.
d. Over the holes in top of the bell cap and completely around the edge of the bell cap where it screws onto the regulator castings. Any bubbles here indicate leakage past the diaphragm.
e. Around union nut which attaches hose which leads to the ice box.
f. On the gauge studs where the gauges screw in to the castings.

NO. 2. TO REPAIR TANK REGULATOR VALVE, SAFETY VALVE AND DIAPHRAGM - Defects in the safety valves are rare. More often when leakage discharges through the safety valve it is the regulator valve that leaks and builds up pressure underneath the diaphragm beyond that at which the safety valve is set, and the safety valve opens normally to release the pressure. Therefore before disturbing the safety valve, first replace the regulator valve with a new one as follows:

a. Start with clean hands. Any oil on the valve will ignite in the presence of oxygen under pressure.
b. Remove the hexagon cap hut and remove the spring and valve.
c. Open a tank to blow out debris.
d. Wipe out the valve chamber with a clean lintless cloth.

e. Replace the parts supplying a new valve.
f. Tighten the cap nut firmly to seal.
g. Test the safety valve and if it leaks screw off the knurled valve casing with the fingers. Carefully loosen with pliers if necessary.
h. Clean off the valve seat, or preferably replace with a new one. Do not disturb the screw adjustment at the outer end of the sleeve.
i. Again test.
j. If adjustment appears necessary loosen lock nut on adjustment screw and gradually tighten and test until leakage stops.

NO. 3. REGULATOR DIAPHRAGM - To replace regulator diaphragm with a new one.

a. Screw off the regulator bell cap and remove the diaphragm. If damaged put on a new one.
b. Paint a thin film of Q-Seal on the surface near the outer edge of the diaphragm where it contacts the diaphragm seal on the regulator casting. The diaphragm seat should be wiped clean.
c. Screw on the regulator bell and tighten firmly to place.

NO. 4. TO CLEAN AND REPAIR FLOWMETER - To remove the flowmeter from the machine head:

a. Remove (screw out) needle valve.
b. Slightly loosen the hex union nut which attaches to the bottom of flowmeter tube.
c. Screw out the hex bolt which attaches the flowmeter to the back manifold.
d. Screw off the nut first loosened.

To remove the float indicator the hands should be clean and dry.

e. Invert the flowmeter and with a knife or screw driver carefully remove the retaining ring positioned inside of the very end of the tube.
f. Place the palm of one hand over the end of the tube while turning the gauge right end up. Carefullv lift the gauge slowly and let the indicator float drop out in the hand.
g. Handle float gently and wipe it off with a clean lintless cloth. Avoid unnecessary handling.
h. The glass tube of the flowmeter can be wiped with an ordinary pipe cleaner which can afterwards be bent double for wiping the inside wall of the tapered flow tube. Avoid using any material which would leave lint or fragments within the tube.
Never blow the breath into the tube as moisture will be precipitated and might interfere with free action of the float.

To replace the float:

i. Invert the flowmeter and drop the float stem downward into the tube. If the stem does not immediately find the opening into the glass tube the float will protrude. Do not press on the flowmeter float as it cannot be shoved into place. Simply shake the gauge gently until the float stem drops to place.
j. Replace the float-retention-ring and reassemble on the machine.
k. Should the float be at all damaged, replace with a new one.

NO. 5 - Emergency-flow valve repairs, though simple, require explanation to insure a successful result. Reference should be made to the accompanying sectional view of the valve.

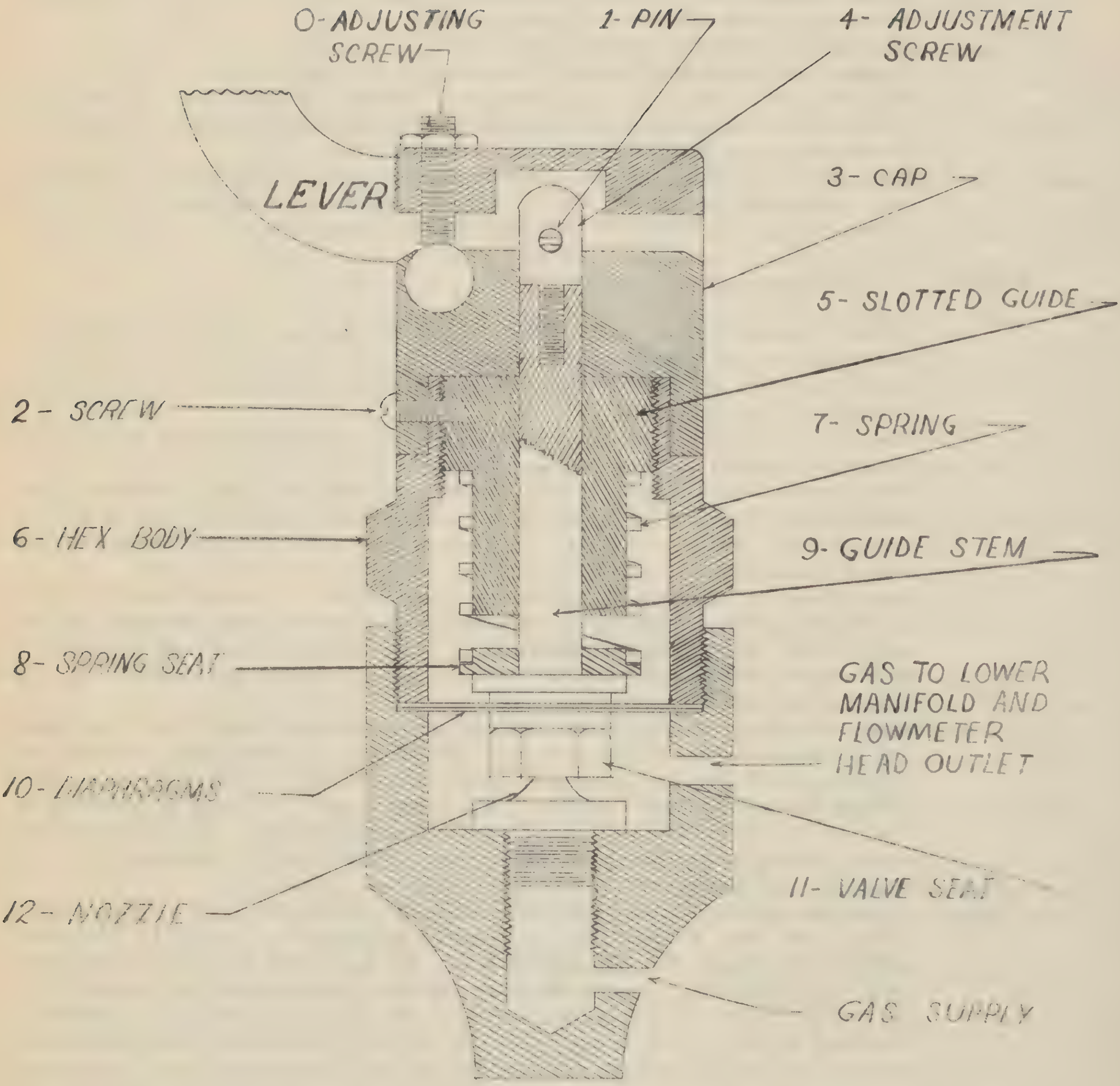
a. To disassemble, first remove pin "1" and lift off the lever.
b. Remove screw "2". Note it was countersunk in part "5", and must again enter this countersink when reassembled.
c. Lift off cap "3" - do not lose the ball bearing.
d. Screw out adjustment screw "4" and slotted guide "5".
e. Unscrew hex. body "6" with wrench. Remove spring "7", spring seat "8" and diaphragm ring. Then remove the assembly of guide stem "9", diaphragms (or diaphragm) "10", and valve seat "11".
f. Using small vise or pliers and wrench, separate guide stem, diaphragms (or diaphragm) and valve seat. (Two diaphragms are now used).
g. Clean nozzle "12" and its chamber in the manifold.

Assemble as follows:

h. Replace assembly "9", "10", "11", with diaphragm ring and spring seat "8" (sleeve end up) in place on stem "9".
i. Screw slotted guide "5" about half way into hex. body "6". (Spring "8" should be left out).
j. Now place "5" and "6" over stem "9" and screw part "6" *tightly* to place in manifold.
k. Now remove slotted guide "5", insert spring "7", and again replace guide "5", screwing it in until it hits bottom, then back it up 4/5ths of a turn. Put on cap "3" to lock screw hole points forward, and drive screw "2" to place.
l. Next screw in adjustment screw "4" until there remains from 3/64" to 1/16" of space between the bottom of the screw head and the top of guide stem "9". Simultaneously the hole through the head of adjust. ment screw "4" must line up with the hole through the side of the lever casting to admit pin "1".
m. Before putting on the lever turn on the gas supply and test the valve for leakage by putting a film of strong soap suds over the opening through which the gas issues from the flowmeters to the patient. If a bubble forms the valve leaks. The remedy lies in lightly tapping on the top of adjustment screw "4" with a light hammer. This drives the hard rubber valve seat against nozzle "12" which indents the seat material sligbtly and stops the leak.
n. To put on lever, first back out screw "0" about two full turns. After lever has been pinned on, re-adjust screw "0". This is THE MOST IMPORTANT PHASE OF THE ASSEMBLY. IF SET TOO FAR IN, CONTINUAL LEAK WILL RESULT. A method that insures the proper adjustment is, with a cylinder of gas turned on and the opening from the flowmeters covered with strong soap suds, to slowly screw in the adjustment screw "0" until a soap bubble begins to form where the suds were applied. Now back out screw "0" sufficiently to allow the valve to completely close as evidenced by no further enlargement of the bubble, and while holding the screw in that position, "set" the lock-nut on the screw tight against the lever casting. A slight up and down play of the handle indicates it to be in proper adjustment.

NO. 6. TO REPLACE BEVEL GEARS ON ELEVATING SCREW

a. Remove spun brass housing from top of the center upright post. Bevel-



EMERGENCY FLUSH VALVE

ed gear wheels will be exposed.

b. Hold first nut directly under beveled gear with a wrench and loosen nut at top of stem. Then loosen nut directly thereunder.
c. Apply a wrench to each of the nuts at top of stem and lock them tightly together.
d. Hold the lower of the two nuts at top of stem with a wrench and loosen the second nut located below beveled gear. Then unlock the two nuts above the gear and remove them.
e. Screw off beveled gear.
f. The other bevel gear wheel is anchored to the crank shaft by a tapered pin, the larger end of which is up when the crank is in down position. Therefore to remove the gear wheel raise the crank handle up and drive out the pin.
g. If gear wheels are damaged replace with new ones.

Re-assemble as follows:

h. Before putting on the small gear wheel insert the tapered lock pin to see on which side of the gear shank is the large end of the tapered hole. Mount the wheel with this side up and the crank handle down and drive in the pin.
i. Screw on other gear to completely mesh with pinned on gear wheel but not to bind unduly. Lock nuts, beneath, up snugly to it.

NO. 7. AIR SIPHON - It circulates the air from the tent hood through soda lime and ice box. The nozzle is the only part which may need attention. Its opening is protected from stoppage by four layers of fine screen.

To clean the nozzle or replace it with a new one:

a. Remove soda lime basket.
b. Unscrew nut which joins oxygen supply tube to injector bracket and spring the tube away from the bracket. This frees the siphon for removal from the soda lime chamber.
c. Remove plug bolt that holds injector in place. Be careful not to lose its gasket.
d. Screw out injector nozzle and clean its opening with a small wire probe.

AMERICAN HOSPITAL SUPPLY TENT

OPERATING AND ASSEMBLY INSTRUCTIONS FOR THE "OXYGENAIRE" - (Motorless Type--Operates without Electricity) - UNCRATE CAREFULLY AND INSPECT THOROUGHLY.

No. 1 The Tent proper.

No. 2 Oxygen Regulator, Adapter and Wrench.

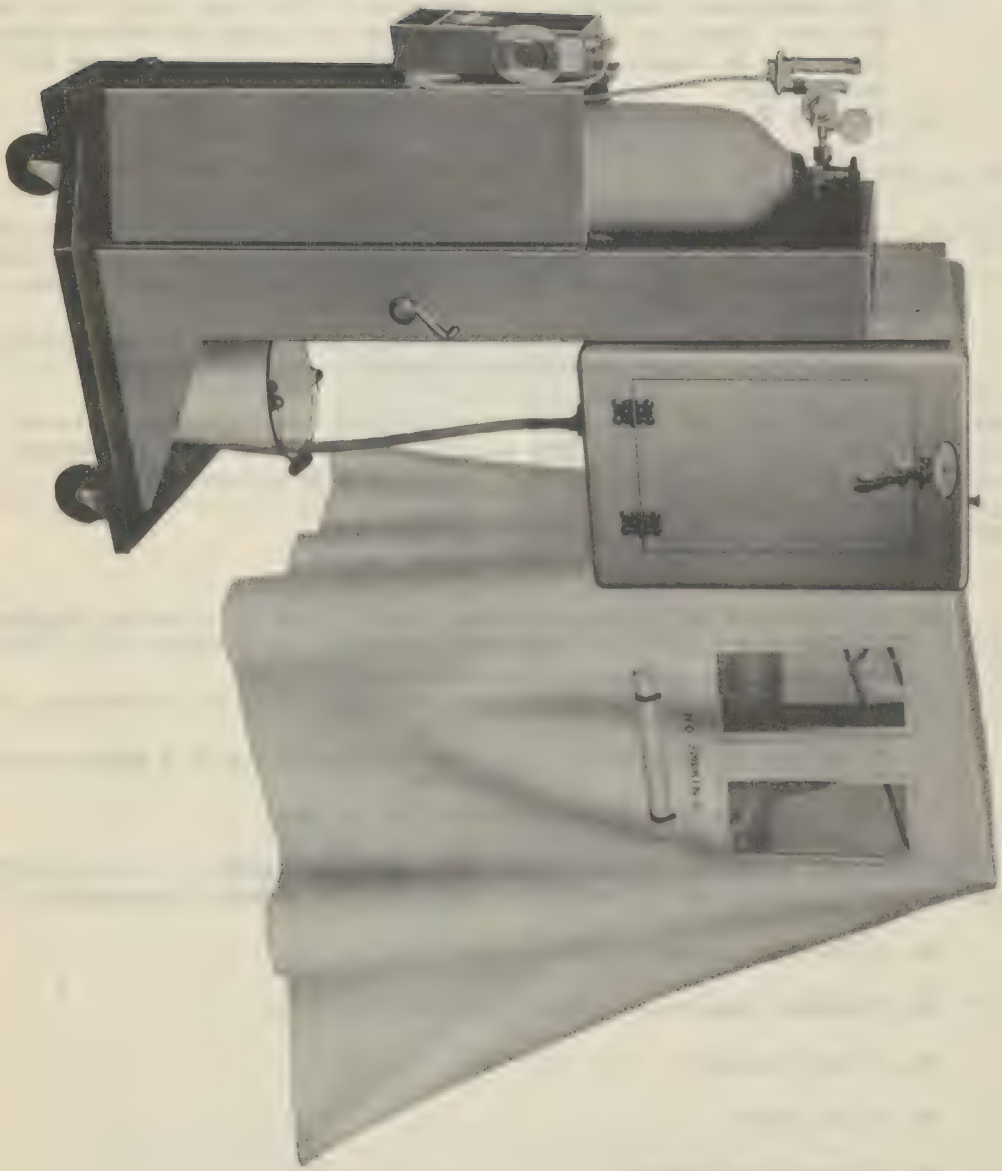
No. 3 Tent Canopy.

No. 4 Ice Basket.

No. 5 Soda Lime Basket.

No. 6. Rubber Hose for Oxygen.

No. 7 Rubber Hose for Bottom Drain.



SIDE VIEW OF AMERICAN HOSPITAL SUPPLY OXYGEN TENT WITH CABINET CLOSED

No. 8 Drainage Pail

No. 9 Gas Analyzer

No. 10 Removable Shelf

No. 1. The main unit is in complete assembly, and only a little attention to minor parts is necessary.

No. 2. The Oxygen Regulator comes intact with Oxygen Pressure Gauge, Liter Flow Gauge and Flood Valve all connected together ready to be attached to the oxygen tank. The Liter flow Gauge is made of transparent material so that the oxygen flow is visual. The Regulator will fit any size tank of commercial oxygen. When size "G" or "M" tanks of Medicinal oxygen are to be used, the Adapter which is provided must be employed between the Regulator and Tank Outlet. A wrench is also provided for attaching the Regulator and Adapter securely to the oxygen tanks.

No. 3. The Tent Canopy is hung on the "U" shaped supporting frame, and the elastic opening in the Tent is arranged into the receiving channel which encircles the front edge of the Cabinet. The channel is opened to receive the Tent and then snugly closed by means of the four (4) thumb screws on the front of the Cabinet. Tent should be arranged carefully so that the two upper windows are in the exact center of the top.

No. 4. The Ice Basket will be found in place in the Cabinet.

No. 5. The Soda Lime Screen or Basket will be found in place immediately across the inside of the upper opening of the Cabinet where the atmosphere comes in from the Canopy when the Tent is in use.

No. 6. The Oxygen Hose is to be connected at one end to the outlet of the Regulator. The other end is to be connected to the Oxygen Inlet at rear of Cabinet at the bottom.

No. 7. Connect Drain Hose to the Drain Outlet at bottom of Cabinet and place other end in Drainage Pail.

No. 8. The Drainage Pail is to be placed on the platform of the Tent in the space provided.

No. 9. The Gas Analyzer can be attached to the Swinging Apron Tent located at the rear of the Tent.

No. 10. Attach Removable Shelf in place provided at front of Cabinet.

OXYGEN CYLINDER - The tank is to be seated in the Housing and the Swinging Apron is closed around it and firmly fastened. Be sure the Tank Outlets face properly so that when the Regulator is connected the Liter Flow and Tank Pressure Gauges are visible. Fasten Regulator to tank snugly by means of the Wrench which is provided.

THE REGULATOR - (See Illustration No. 4). When the Control Regulator is properly attached to the tank, see that the Regulator Handle is turned to the left until completely loose. Open the tank. The right hand gauge on the Regulator should show immediately both tank pressure and tank capacity. (Be sure you get a full tank, and check contents frequently to prevent running out of oxygen. Assure

SIDE VIEW OF AMERICAN HOSPITAL SUPPLY TENT WITH CANOPY

yourself that several extra full tanks of oxygen are in the institution whenever the tent is put into service.)

Open the Regulator by turning the handle to the right. Keep turning until the gauge on the left shows oxygen is flowing. Regulate to suit by moving handle. The oxygen flow is controlled by this handle. The center of the steel ball should be lined up with graduation line indicating oxygen flow wanted.

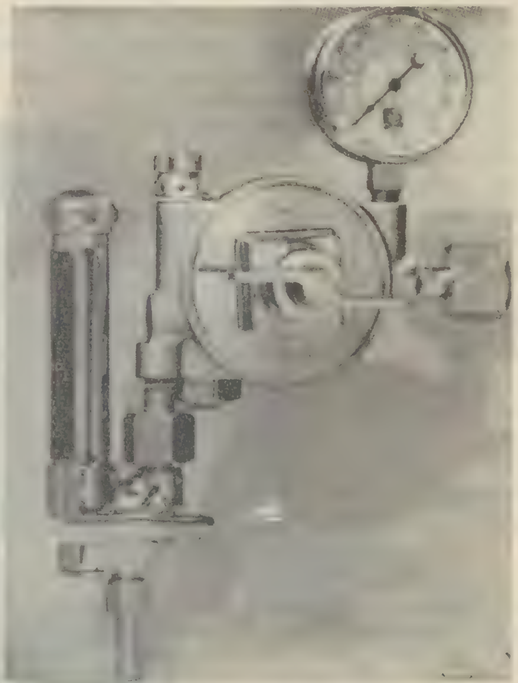


ILLUSTRATION NO. 4

ADJUSTING TENT - With ice in place and oxygen properly connected, you are ready to begin therapy. (See Illustration No. 5). The greater care you exercise in tucking the Tent well under the mattress on three sides and folding under covers over the patient's body, the more efficiently you can use the oxygen. Careless adjustment only results in unnecessary wastage of oxygen. A rubber blanket under the patient will greatly diminish oxygen waste in therapy. For greatest efficiency, the rubber blanket should be UNDER THE MATTRESS so as to make an air tight seal with the three sides of the tent where it is tucked under.

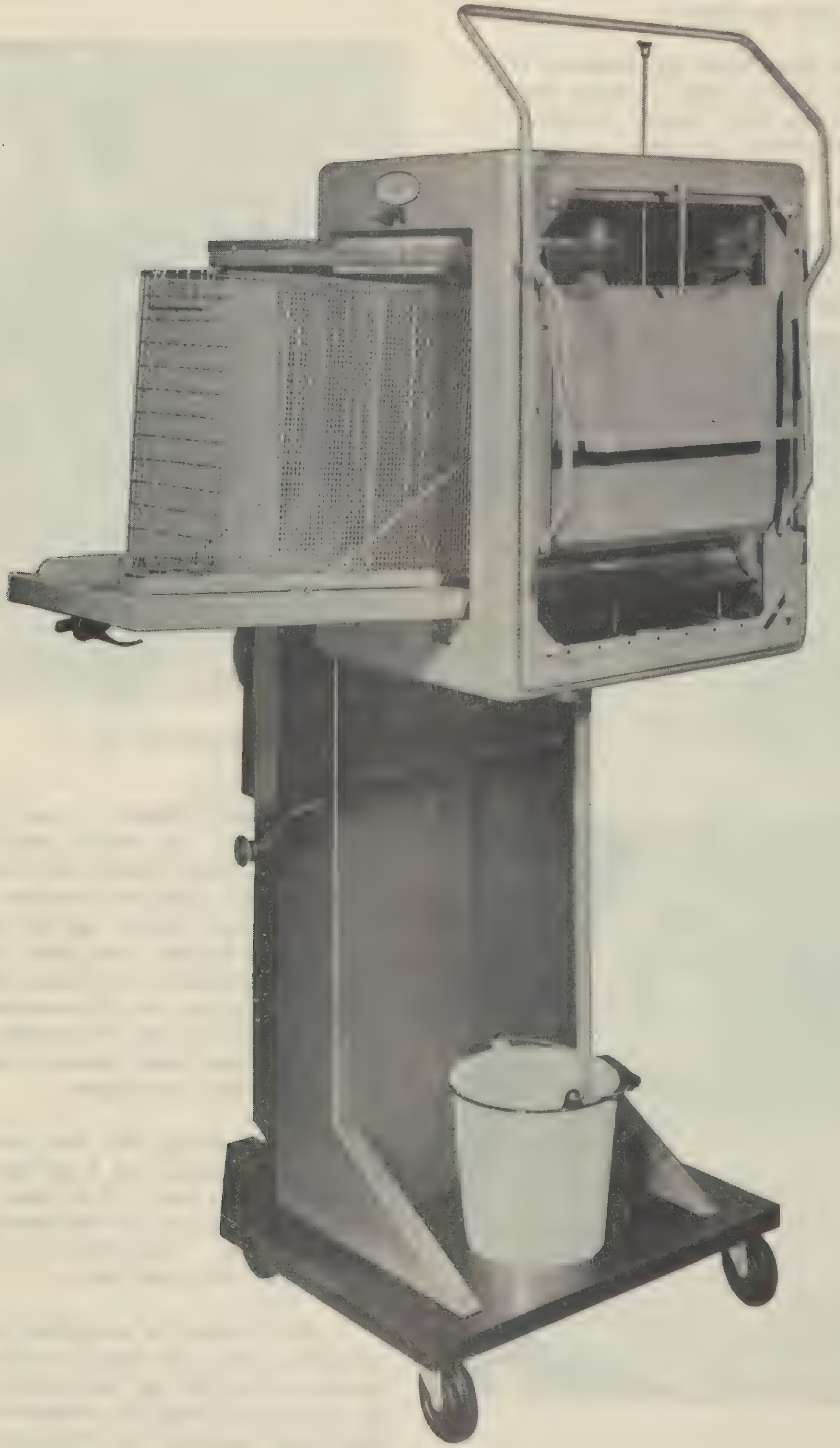
ILLUSTRATION NO. 5

THE TENT CANOPY - (See Illustration No. 6). To raise and fold the Tent back, just grasp the top of the Tent in the center between the two windows, raise center up and pull Tent back over Cabinet. The Tent folds back over the Cabinet and stays in place, without injury to the windows. The lower apron of the Tent may then be hung over the Tent Supporting Frame, all ready for use again.

When putting the Tent over a patient, the canopy is kept up in this closed position. The Tent is then placed by the bed in the best position for therapy. The Tent is then let down over the patient.

The Canopy is provided with three sleeves for patient's care. Keep sleeves rolled up and held in place by elastic loops to conserve oxygen when not employed in the care of the patient.

OBLIQUE VIEW OF AMERICAN HOSPITAL SUPPLY TENT WITHOUT CANOPY



THE SHUTTERS - (Illustration No. 7). When you are ready to start therapy, OPEN THE SHUTTERS. Keep them open! Watch the knob on top of Cabinet. If that knob is down to its full depth, it is a danger signal--"The Shutters are closed." They are used to cut down some of the air circulation, but should never be closed except when you are re-icing the Basket or when adding new soda lime. When giving therapy to children or babies, the Shutters may be half closed until the lower Shutter is just even with the air deflector in the middle of the lower outlet. The Shutters should be closed when the door of the Cabinet is opened for any purpose. This will keep your oxygen concentration in the Tent undisturbed, and you will lose only what is in the Cabinet. The oxygen continues to flow into the Tent with the Shutters closed and the Cabinet Door open.

ILLUSTRATION NO. 6

These shutters, operated by a *single* control, adjust the speed of circulation. They also close off the canopy completely when you re-ice.

If you close the shutters before opening the cabinet you lose only the oxygen which is in the cabinet. The oxygen continues to flow into the tent with the shutters closed and cabinet door open.

OXYGEN CIRCULATION SYSTEM - The O_2 goes through the bottom of Cabinet. It enters the Tent through the series of little holes in the lower casing of the front frame of the Cabinet. These small holes diffuse the oxygen before it reaches the patient. (See Illustration No. 8). The oxygen flow is now ready--next, fill soda lime basket and put Ice Basket in place.

ICING - (Illustration No. 9). Care must be used in icing the Basket. Ice too fine mats and retards convection. Lumps too large cut down the ice surface exposure. USE LUMPS THE SIZE OF YOUR FISTS. This is important!

The Ice Basket may be filled while on the suspended Cabinet Door, then slide into place in the Cabinet, close and fasten door. Keep the two Shutters closed while icing or re-icing, but be sure to open them immediately after, and before Oxygenaire is put in service.

ILLUSTRATION NO. 7

ADJUSTING CABINET HEIGHT - The cabinet is easily adjusted vertically by the gear handle on the right side. The Cabinet should be set about six inches (6") above the level of the bed. If used on a cardiac case, in a sitting position, the Tent and Cabinet should be adjusted higher accordingly. (Illustration No. 10).

SODA LIME - It is recommended when using soda lime in the tent that a 4-8 mesh, 14-19% moisture content lime be used. About two (2) pounds of Soda-Lime will be required every twenty-four (24) hours. This should be evenly distributed over the bottom of the soda lime basket.

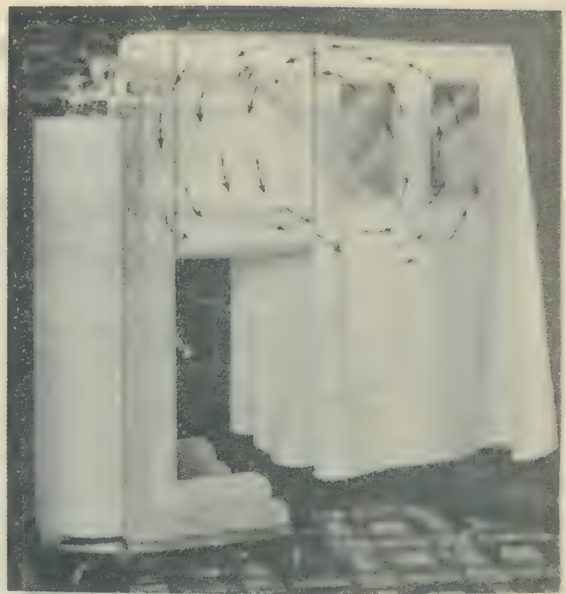


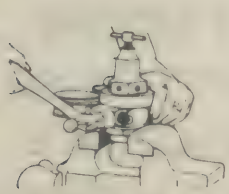
ILLUSTRATION NO. 8

ILLUSTRATION NO. 9

ILLUSTRATION NO. 10

THE MAINTENANCE AND REPAIR OF AMERICAN HOSPITAL SUPPLY OXYGEN TENT REGULATOR

GENERAL - The Oxygen regulator furnished with the American Hospital Supply Corporation Tent consists of a Rego Model 6122 regulator assembly, in accordance with the Medical Supply Depot's specification, except that a No. 2090 spring loaded safety relief device is incorporated in place of the pipe plug shown on the drawing.



In general it may be stated that the most common source of difficulty with pressure reducing regulators results from careless handling when changing full cylinders to replace empty cylinders. Before attaching any regulator to any source of supply of oxygen, the cylinder valve should be momentarily opened to dislodge any foreign matter which would otherwise be discharged into the inlet of the regulator and which would have an extremely erosive wear upon the seat of the regulator. The lodgement of such foreign matter on the seat will prevent the positive shut-off of the regulator.

CAUTION - IMPORTANT! - Under no circumstances should any oil or substance containing oil or any other form of lubricant whatsoever be employed on any part of the oxygen control equipment.

HOW TO PUT IN A NEW SEAT - Refer to accompanying illustrations.

1. Turn the adjusting screw to the right (#1620-4) to lift the seat #33-16 off the nozzle No. 919-15. This is important.

2. Place the backcap #1620-3 in a vise and tap the outlet lug of the regulator body #1620-1 lightly with a small hammer, turning the body to the left until the backcap is removed.

3. Remove four screws #1600-20 in seat retainer centerpiece #1600-17.

4. Using a screwdriver with perfectly straight or concave edge about 7/16-inch across its face, remove seat retaining ring #33-19. Push the old seat #33-16 out of the seat retainer ring.

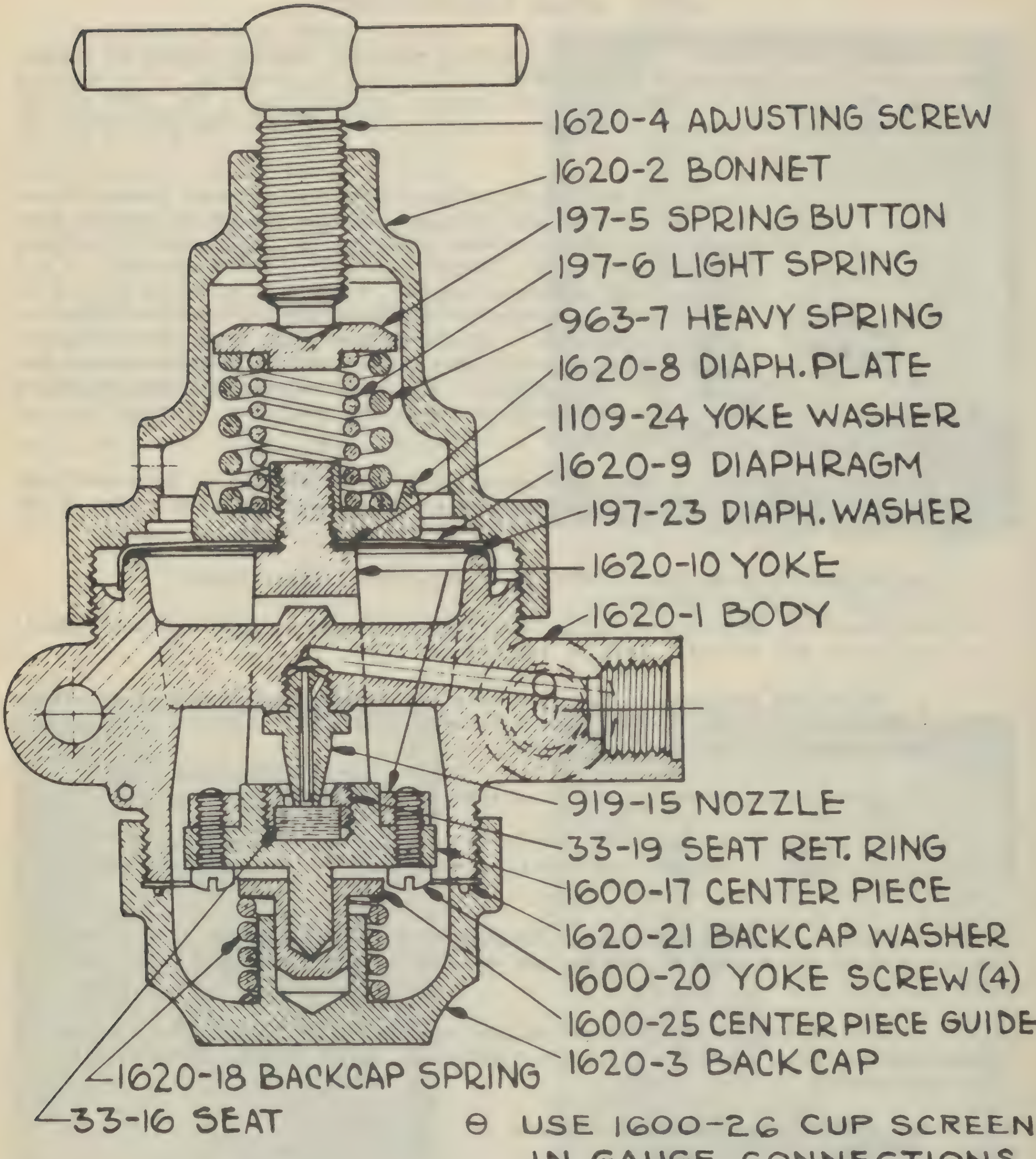
5. Insert new seat, pushing or tapping it snugly into place with a *block of wood*. #33-16 has a tapered surface and will go into the retainer ring from only one face.

6. Replace parts. Use a new backcap washer #1620-21 *dipped in water* to lubricate and insure against tearing. Tighten all parts snugly, using care not to scratch seating surface.

7. Back off adjusting screw #1620-4.

8. Attach the regulator to a cylinder and while holding the finger tight over the outlet, turn the adjusting screw all the way in and then all the way out. Release your finger. This action forces the nozzle to indent slightly into the seat and forms a gas-tight joint.

HOW TO REPLACE A FATIGUED DIAPHRAGM - Refer to accompanying illustrations.



2" OXYGEN REGULATOR
REGO TYPE XL

Part #1620

1. Place two flat faces of the hex bonnet #1620-2 in a vise.

2. Remove backcap #1620-3 with wrench. Remove seat retainer centerpiece #1600-17 as outlined in foregoing.

3. Turn Body #1620-1 with wrench to left and unscrew spring housing as illustrated (Spring housing being the bonnet #1620-2).

4. Remove old diaphragm #1620-9, diaphragm plate #1620-8, and yoke assembly #1620-10 by prying along the edge of the diaphragm using the edge of a screwdriver or large coin.

5. Disassemble the diaphragm plate from the yoke with a screwdriver and pliers as illustrated.

6. Put new diaphragm on yoke using new alloy washer #1109-24 (Dipped in water) between yoke #1620-10 and bottom of diaphragm. Install Diaphragm Plate #1620-8, tightening snugly together with pliers and screw driver as illustrated. Install new alloy washer #197-23 (Dipped in water) between bottom of diaphragm #1620-9 and 2 body #1620-1.

7. Replace assembly of yoke and diaphragm using care to place yoke so that it is centered about the bridge and does not touch the bridge at any point, as illustrated. That is, legs of yoke should be concentrically parallel to edges of bridge.

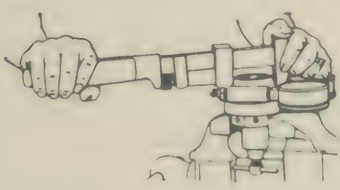
8. Replace springs #197-6 and #963-7 on top of diaphragm plate #1620-8 and with button #197-5 on top of springs.

9. Screw on spring housing (#1620-2 bonnet) by hand. Place two flat faces of the hex bonnet in a vise and tighten snugly with monkey wrench as shown in sketch opposite Note 3 hereof.

10. Examine seat and nozzle, replacing same if necessary as instructed heretofore.

11. Turn adjusting screw to right. Reassemble seat and backcap, using new backcap washer #1620-21 dipped in water as explained theretofore.

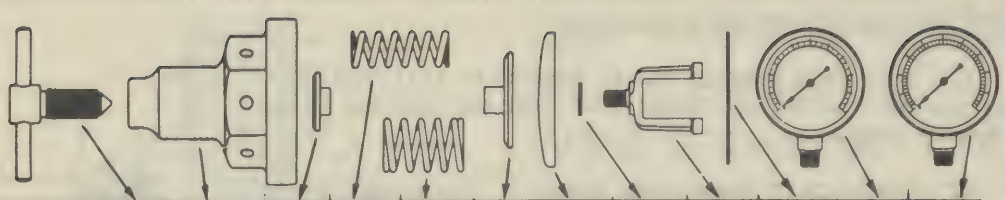
HOW TO REPLACE WORN NOZZLE



1. Remove backcap #1620-3 following procedure 1, 2, and 3 as outlined for removal of seat.

2. Remove nozzle #919-15 with hex socket wrench that clears surface of nozzle properly.

3. Put in new nozzle (Dipped in water) of identical type to that which was removed from the regulator, tightening same snugly, and be sure the nozzle is exactly the same size as the one removed. Be certain that the nozzle is equipped with a pin located on the axil center of the nozzle orifice. This is for the purpose of absorbing, the sudden heat of recompression which occurs when any operator unwisely opens

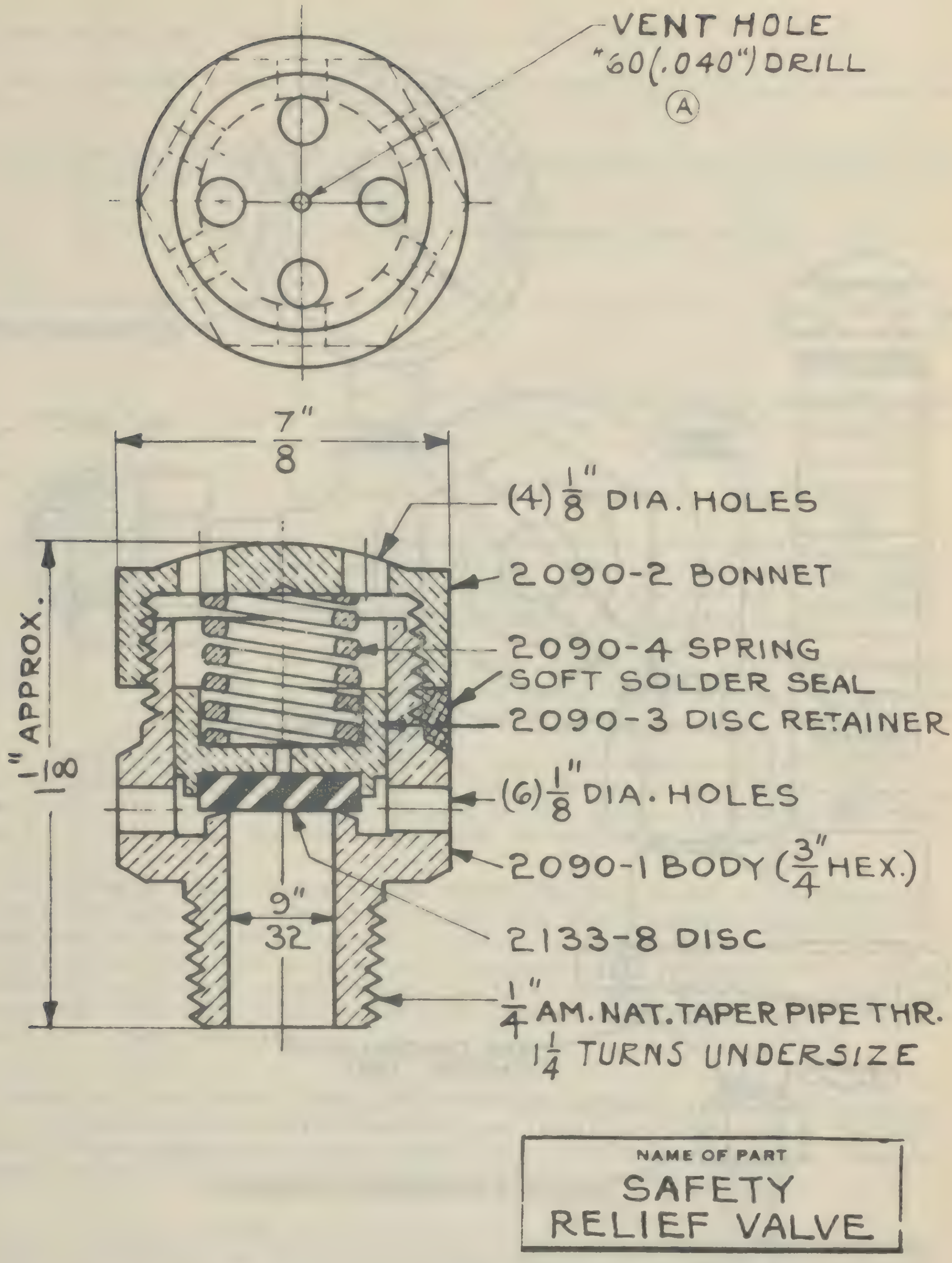


Regulator Number	Adjusting Screw	Bonnet	Spring Button	Light Spring	Heavy Spring	Diaphragm Plate	Diaphragm	Yoke Washer	Yoke	Diaphragm Washer	H P Gauge	L P Gauge
1620	1620-4	1620-2	197-5	197-6	963-7	1620-8	1620-9	1109-24	1620-10	197-23	1154	

Body	Outlet Bushing	Outlet Swivel Conn	Inlet Connection	Nozzle	Seat Ret Ring	*Seat	Center Piece	Yoke Screw	B O Spring	B C Washer	Back Cap	Centerpiece Guide	Regulator Number
1620-1	3881	3782-4	967	919-15	33-19	33-16	1600-17	1600-20	1620-18	1620-21	1620-3		1620

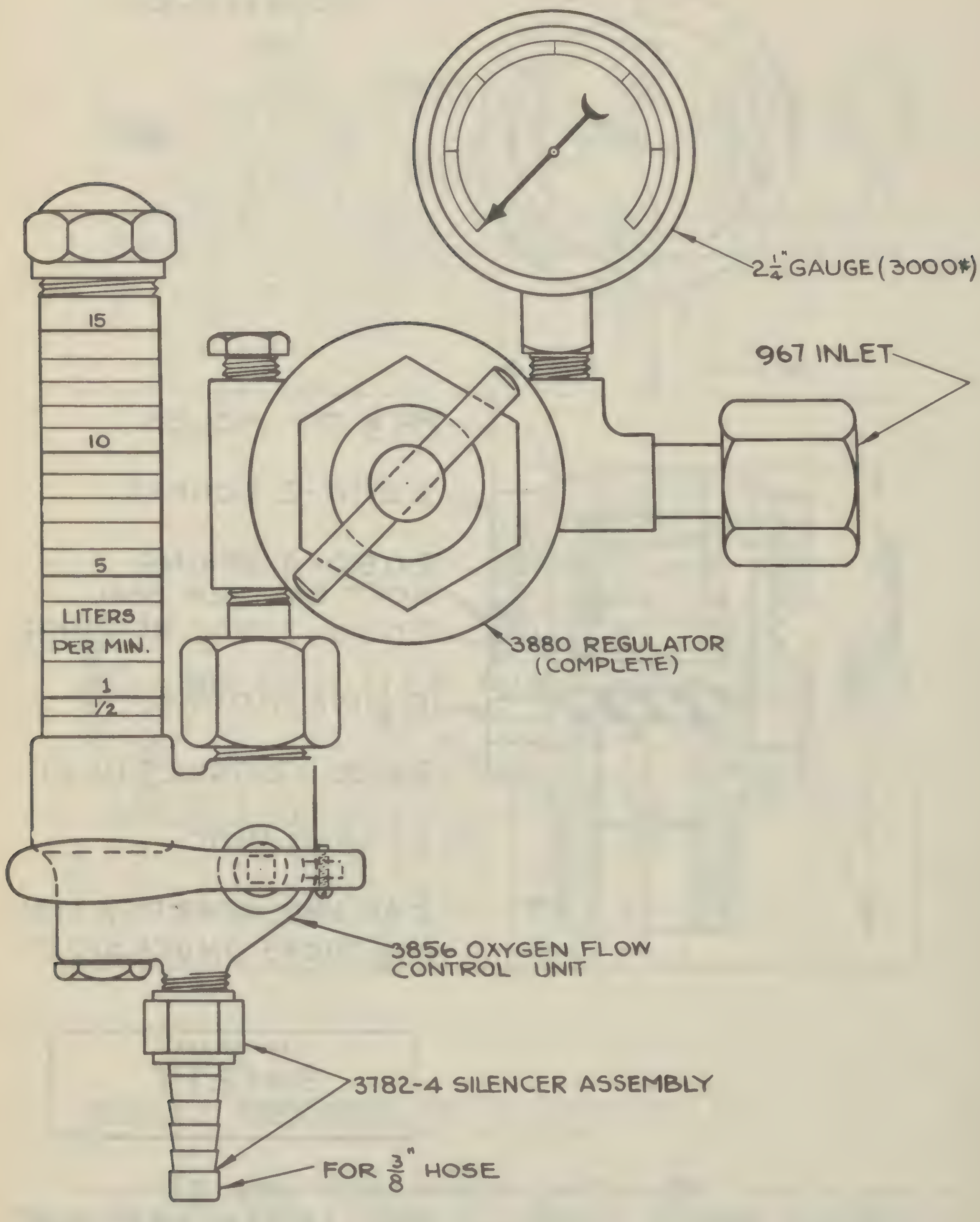
REPAIR PARTS FOR "XL" SERIES AND LINE REGO REGULATORS

Every REGO Regulator has a number stamped on it. In the tabulation above the part is shown, and opposite the regulator number the page number of the manufacturer's parts catalogue is shown.



(B) INITIAL LEAK 325 LBS. □"

(C) USE SPRING 2090-4A FOR 150 LB. SETTING



AMERICAN HOSPITAL SUPPLY OXYGEN TENT REGULATOR

cylinder valve with a sudden jerk.

HOW TO REPLACE A WORN INLET - Referring to Regulator #1620 and Illustration T-6122.

1. Turn adjusting screw #1620-4 all the way in to lift seat #33-16 off of nozzle #919-15. *THIS IS IMPORTANT.*

2. Wrap body #1620-1 of regulator and 3000-pound gauge in a wet cloth (Very wet).

2A. Remove #3856 oxygen flow control unit from regulator by disconnecting the union nut on outlet of regulator.

3. Melt soft solder out of inlet connection #967 nipple using a small city gas torch. Use just as little heat as is possible.

4. Remove old inlet with a small pipe wrench.

5. Heat thread of new inlet #967 nipple with a small gas torch and screw it in, tightening with small pipe wrench. (IMPORTANT: Don't forget to put the #967 nut over the #967 inlet nipple before attaching to regulator body.)

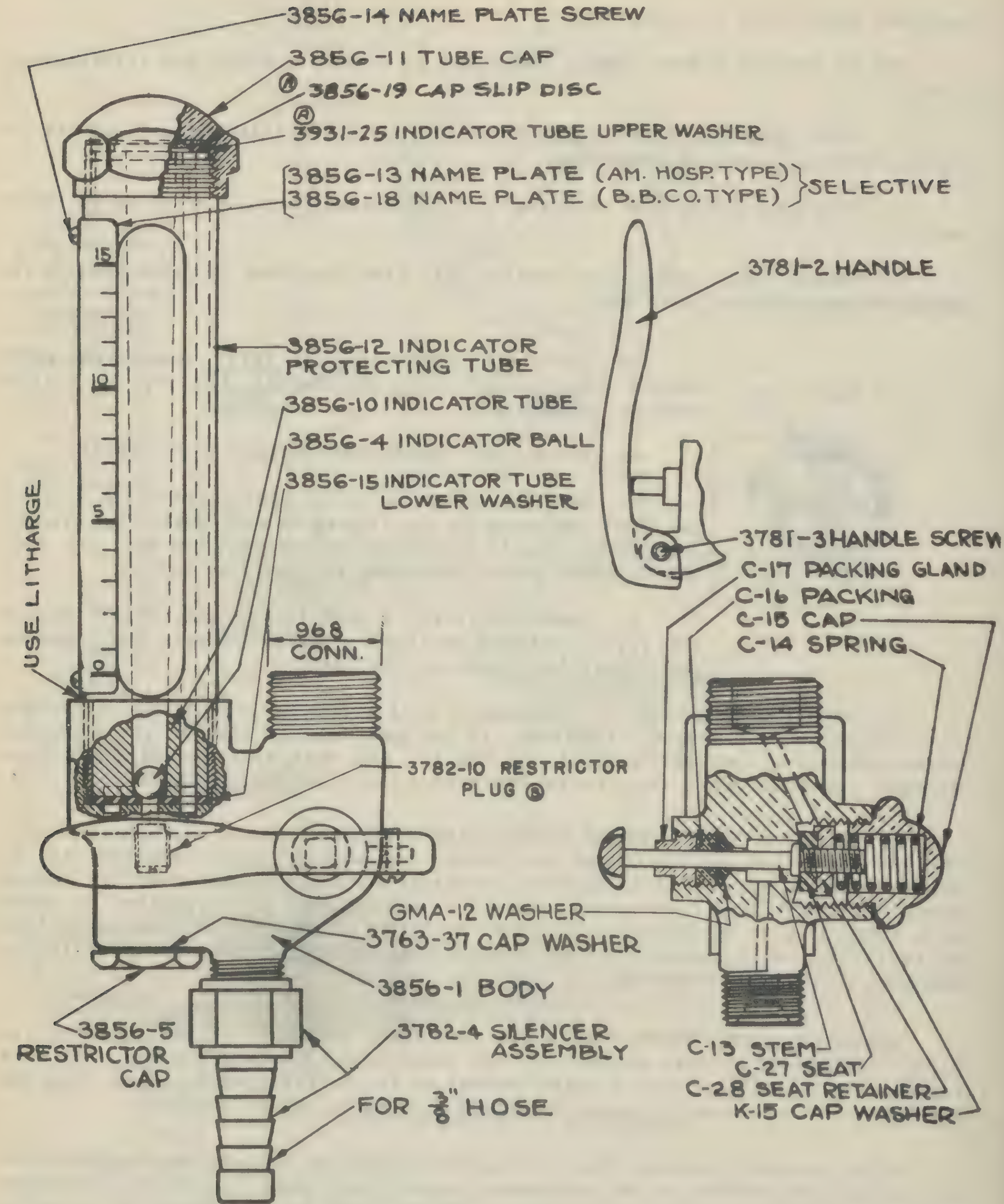
6. Immediately run a very little soft solder around the joint, using a small city torch, playing the flame *on the nipple* but close to the joint.

7. When the regulator is thoroughly cool (and then only), the adjusting screw may then be released. CAUTION: If too much heat is used on the adjusting screw #1620-4 is not screwed all the way in, the seat will usually have been damaged and will hence require replacement as outlined heretofore.

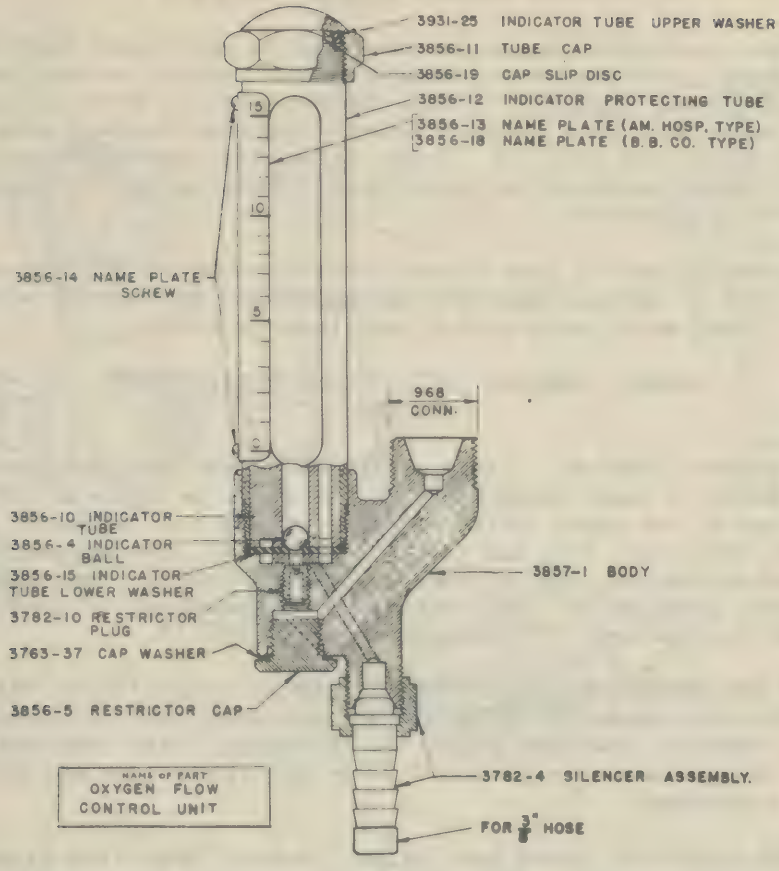
SERVICING OF #2090 SPRING LOADED SAFETY RELIEF - Refer to Illustration. This device is set and sealed at the factory and should not be tampered with by unauthorized persons. If it becomes necessary to replace this part, it can be readily removed from the regulator as it is sealed into the regulator by means of a #2060-35 soft metal washer as shown in Illustration. It will be noted that to facilitate this connection, a 1/4-inch pipe thread on this relief valve is produced 1 1/4 turns undersize.

SERVICING #3856 THORPE TUBE LITER FLOW GAGE ASSEMBLY - Refer to Illustration. The nature of this device does not lend itself to field repair: For this reason - It is equipped with a union connection to facilitate its removal from the regulator, and can hence be replaced without difficulty in the field.

It is remotely possible that foreign matter passing through the regulator due to improper attachment to the gas supply might conceivable follow the restrictor orifice #3782-10. If this should occur, the orifices can be removed for cleaning by first removing restrictor cap #3856-5 and cap washer #3763-37. The orifice plug can be readily cleaned by carefully inserting a common pin or small needle having an outside diameter not greater than a #75 wire gauge drill.



EXTERNAL VIEW OXYGEN FLOW CONTROL UNIT
SECTIONAL VIEW OF FLUSH VALVE



GENERAL INSTRUCTIONS ON MOTORLESS OXYGEN TENTS

Tents operating without a motor, in warm climates especially, require exact attention to the setting up and operational instructions furnished with the tent. The following instructions apply to all motorless tents and special attention should be paid to these points. These instructions have definite bearing for maintaining proper temperature in the tent.

1. Make sure the tent is tucked in very well. Loss of the cooled air through poor application of the canopy to the bed will render the tent extremely uncomfortable, when the tent is in a warm room.
2. Keep plenty of ice in the tent chest. Ice should not be flaked - Pieces should be size of fist.
3. Be sure the oxygen inlet points are free from all obstruction so that circulation in the tent may be the maximum. A tent operating without a motor must have no interference with the flow of oxygen into the tent as circulation in this type of tent depends greatly on free flow of the oxygen into the tent.
4. Be sure soda lime is not caked.
5. Be sure outlet of water drain is water sealed.
6. Be sure that pillows or other bedding do not obstruct openings to and from the canopy and chest.
7. Close openings in the canopy provided for care of the patient, immediately after finishing treatment or care.
8. Inspect the canopy for tears.
9. Be sure any oxygen analysis vent is in the closed position while the tent is in operation.

HEIDBRINK OXYGEN THERAPY OUTFITS

Apparatuses used with compressed gases must be maintained tight at all unions of their component parts and with undamaged rubber parts to prevent gas waste. The application of strong soap suds with a shaving brush at these places and on the rubber parts which must hold pressure readily discloses leakage when the test directions given herein are followed. Simple tightening, new rubber or a rubber patch often stop it, therefore should be tried first. Where specific repairs are omitted, tightening only is indicated.

Rubber parts should be kept clean. Sterilization by boiling or autoclaving shortens the life of rubber, therefore use an aqueous sterilizing solution at room temperature. Clean metal parts with a non-flammable cleaner.

OXYGEN THERAPY OUTFIT FOR ONE PATIENT
TESTS

TANK REGULATOR (25001-A) - Close needle valve with stem and open oxygen tank. With shaving brush or equal apply soap film on parts as follows. If bubbles form there is leakage at the place indicated by them: All over union nut (902), around cap nut (393), over holes, base and top of safety valve (332-1A), over holes in bell cap (4001) and all around edge of bell cap where it screws onto body (25001), on gauge stud where gauge screws into casting and around margin of gauge safety back. (Gauges cannot be repaired. If damaged put in new one.)

BRACKET AND NEEDLE VALVE (25002-A) - Apply soap film on bracket gaskets (7-170), needle valve gasket (7-177), packing nut (5646) and union nut (5620). Remove tubing (26003-1) from rear outlet of flowmeter. With tank valve open, open needle valve until flowmeter registers 1 liter per minute flow and close rear flowmeter outlet with thumb.

FLOWMETER (25015-A) - Open tank valve. Remove thumb from flowmeter outlet. Open and close needle valve. Float should move up and down smoothly.

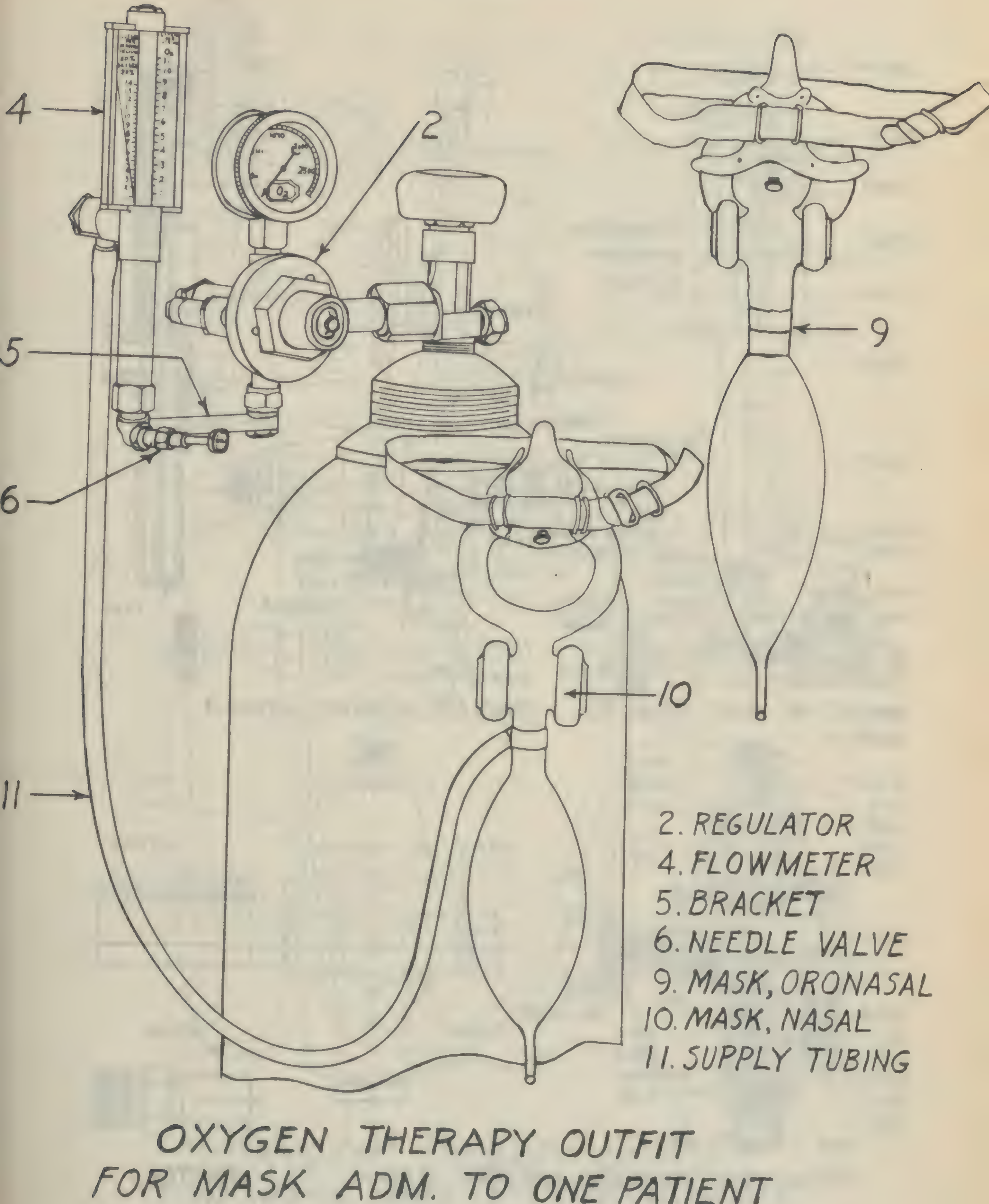
REPAIRS

REGULATOR VALVE (391-A) (Ball Bearing Valve Cage (396-A) - Start with clean, dry hands. Oily hands may be the cause of oxygen ignition. Remove hex cap-nut (393), gasket (7-196), spring (304) and valve (391-A) with ball-bearing valve cage (396-A). Open tank to blow out debris. Wipe out valve chamber with a clean lintless cloth. Clean nozzle (6002-A). If any indentation in rim of hole, remove nozzle with wrench (10-103) and put in new one tightly. Replace parts, supplying a new valve. Tighten cap nut firmly to seat.

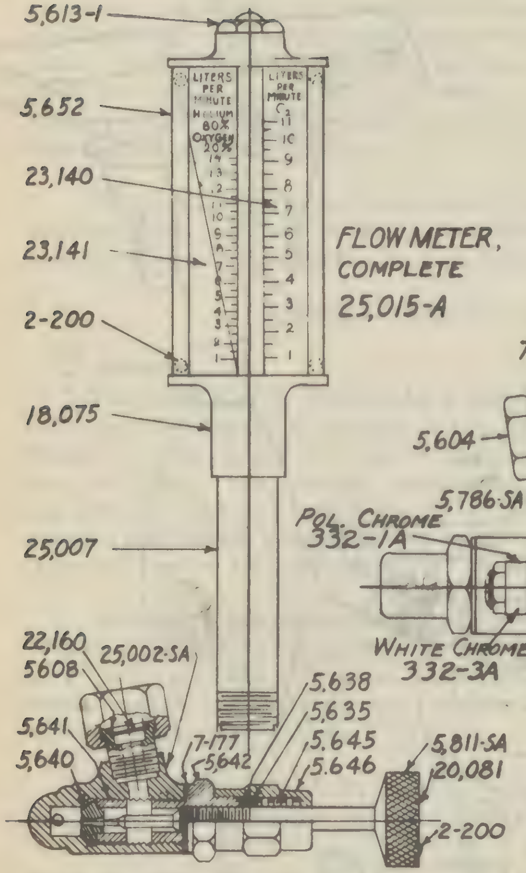
SAFETY VALVE (332-1A) - Leakage disclosed by the safety valve usually indicates leaks through regulator valve (391-A), therefore replace this valve with a new one before disturbing the safety valve.

If safety valve still leaks after regulator valve repair, screw off knurled valve body (327) with the fingers. (Carefully loosen with pliers if necessary.) Drop out valve plunger (328-A) and spring (332-1), wipe off black rubber top of plunger and clean off its seat. (Preferably replace with new plunger.) Do not disturb screw adjustment at end of body. Replace all parts and again test. If leakage persists loosen lock nut (331) on adjustment screw (330) and gradually tighten the screw until leakage stops. Tighten lock nuts.

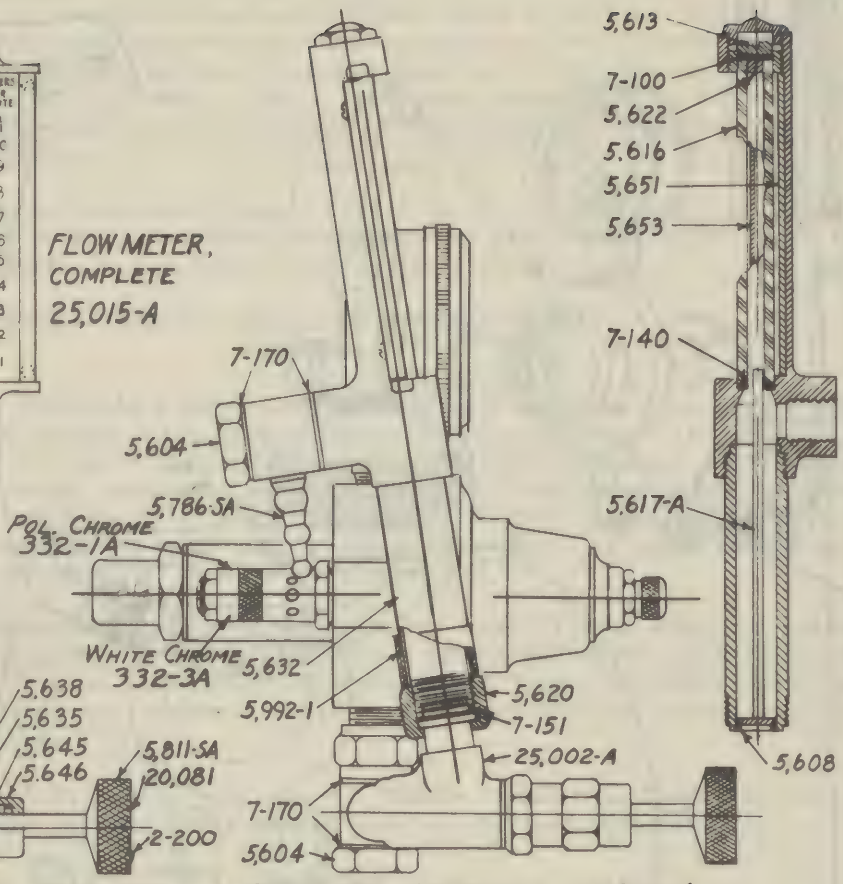
DIAPHRAGM (4007) - Screw off bell cap (4001), lift off spring (4505), spring cap (312) and spring seat (310) and remove diaphragm (4007). If damaged use a



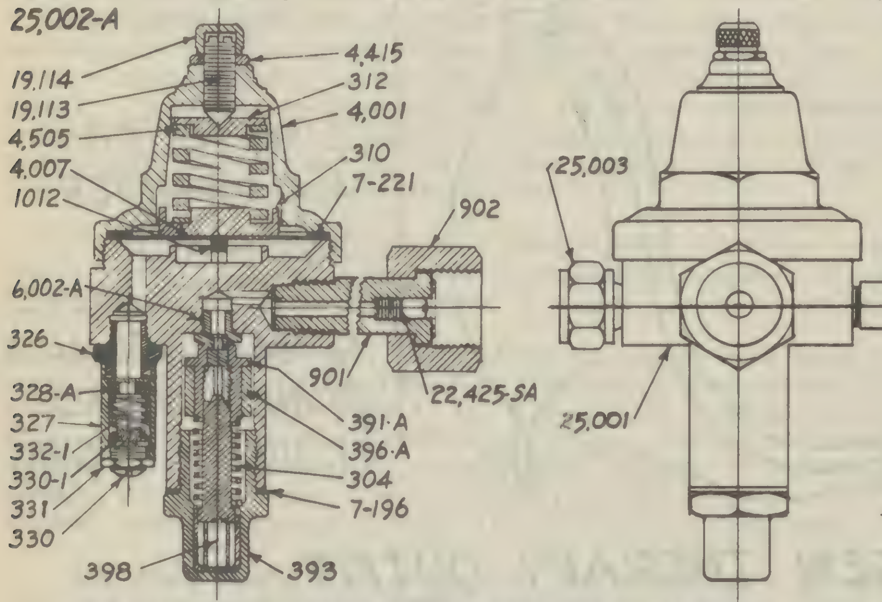
OXYGEN THERAPY OUTFIT
FOR MASK ADM. TO ONE PATIENT



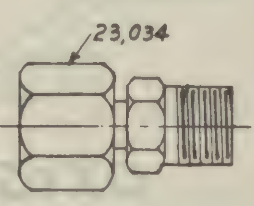
BRACKET AND VALVE, COMPLETE, 25,002-A



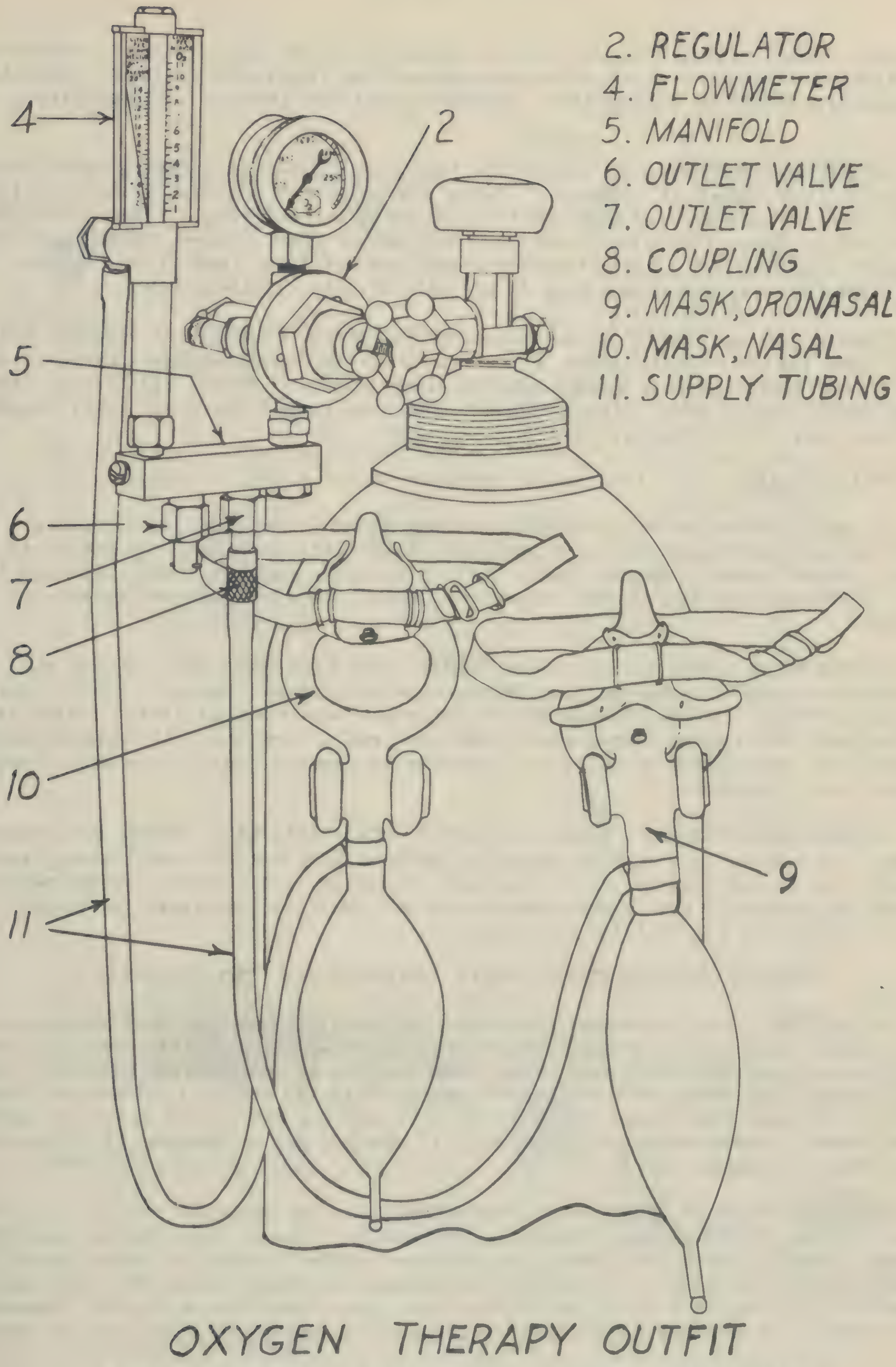
COMPLETE ASSEMBLY, 25,000-A



REGULATOR COMPLETE ASSEMBLY, 25,001-A



ADAPTER



OXYGEN THERAPY OUTFIT
FOR MASK ADM. TO TWO PATIENTS

new one. Paint a thin film of sealing graphite on the surface near outer edge of diaphragm where it contacts diaphragm seat on regulator casting. The diaphragm seat should be wiped clean. Replace parts and tighten bell cap firmly to place.

FLOWMETER (25015-A) - To remove the flowmeter disconnect rubber supply tubing (26003-1) from outlet of flowmeter. Screw off union nut (5620). With dry, clean hands invert flowmeter and with knife or screw driver carefully remove retaining ring (5608). Place the palm of one hand over end of float chamber (25007) and turn flowmeter right end up. Lift flowmeter slowly and let float (5617A) drop out in the hand. Handle float gently and wipe it off with a clean, lintless cloth.

Remove cap nut (5613-1), cap screw (5613), gasket (7-100) and drop out glass float tube (5616). Clean glass float tube with an ordinary pipe cleaner, then use it bent double to wipe inside wall of float chamber. Remove all lint or fragments inside both. Never blow the breath into the tube. The float tube, chamber and float must be absolutely dry when assembled.

Replace glass tube, its gasket, cap screw and cap nut.

To put in float invert flowmeter and drop float (stem down) into chamber. If stem does not find opening into glass tube, float will protrude. Do not press on float. Simply shake flowmeter gently until float stem drops to place. Replace the float retaining ring and attach flowmeter. Should the float become damaged put in new one.

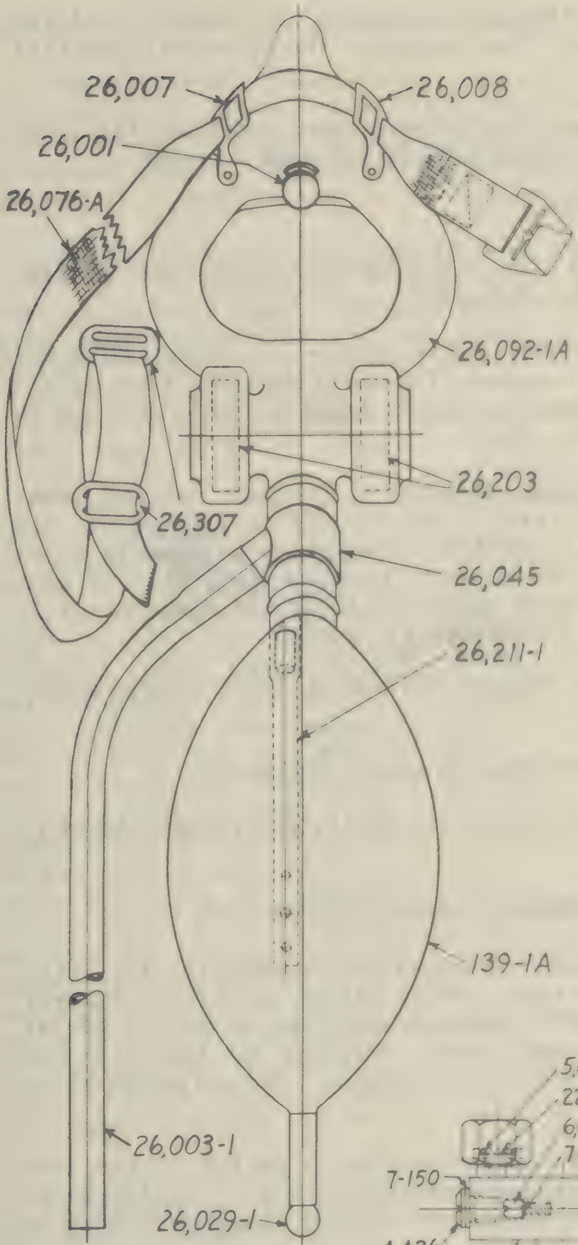
NEEDLE VALVE - Unscrew and remove needle valve stem (5811-SA). Do not pull it through the packing to damage it. Remove needle valve packing nut (5646). Screw out stud (5642). With hex wrench (5639) screw out seat retainer (5641). With long nose pliers then remove copper seat (5640) and put in new one. If tapered end of needle valve has picked up metal or is otherwise damaged, put in new one. Repack packing nut if needed.

NEEDLE VALVE PACKING - Screw out needle valve (5811-SA). Remove packing nut (5646). If packing discs (5638) appear to be good, add one disc and screw on packing nut, but do not tighten it at this time. Screw in needle valve. Do not push it through the packing. Now tighten packing nut and test. If necessary to repack, remove old discs and put in three new ones.

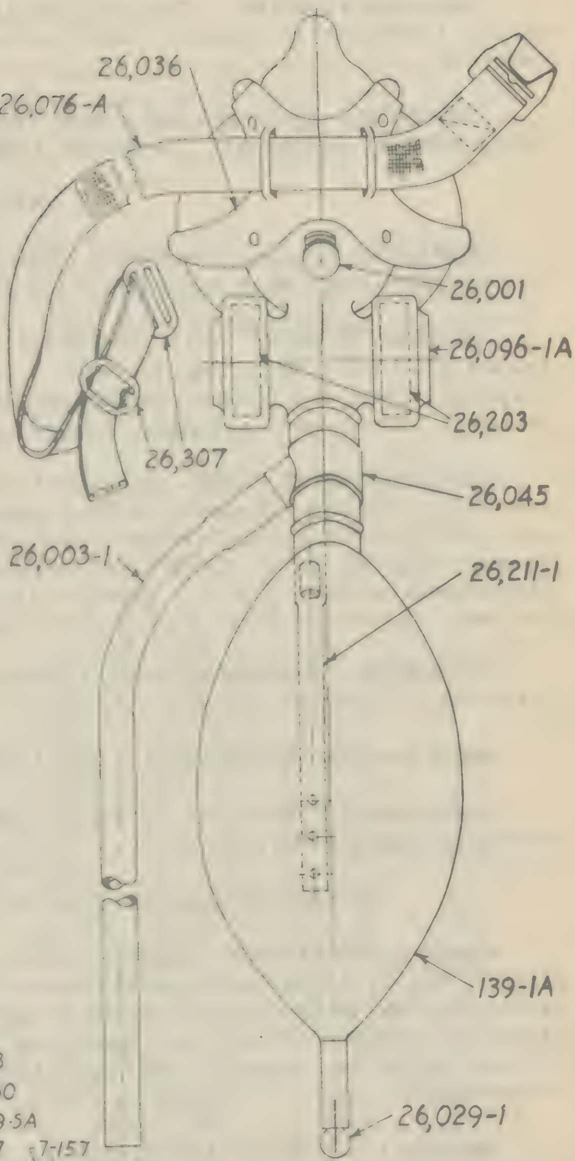
OXYGEN THERAPY OUTFIT WITH MANIFOLD FOR TWO PATIENTS

REGULATOR - Turn handwheel (4003-SA) left until loose and open tank valve. With shaving brush or equal apply soap film on parts as follows: All over union nut (902), around cap nut (393), over holes, base and top of safety valve (332-3A), over holes in bell cap (4001) and all around edge of bell cap where it screws onto body (26001), on gauge stud where gauge screws into casting and around margin of gauge safety back. (Gauge cannot be repaired. If damaged put on new one.) If bubbles form there is leakage.

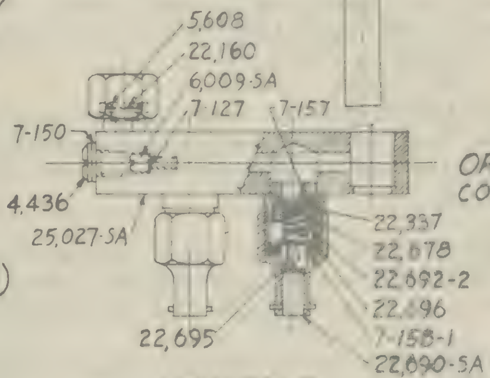
MANIFOLD - Remove plug-in coupling (22686-A) from manifold outlet valve and supply tubing (26003-1) from flowmeter rear outlet. Apply soap film on manifold gaskets (7-170), union nut (5620) and all over outlet valves of manifold and on gaskets (7-170) on rear of flowmeter. Now turn handwheel (4003-SA) right until flowmeter registers at 1 liter per minute flow, then close rear outlet of flowmeter with thumb. If bubbles form there is leakage at the place indicated by them.



NASAL MASK
COMPLETE (26,092-2A)



ORONASAL MASK
COMPLETE (26,096-2A)



MANIFOLD
COMPLETE (25,027-A)

PLUG-IN COUPLING
22,686-A

MANIFOLD FLOWPORT - Obstruction is detected (lacking a test meter) by failure of flowmeter to register up to maximum flow, provided the flowmeter operates smoothly.

FLOWMETER - With tank valve and flowmeter outlet open, open and close regulator with handwheel (4003-SA). Flowmeter float should move up and down smoothly.

REPAIRS

REGULATOR - Loosen handwheel (4003-SA) then proceed as described under "Oxygen Therapy Outfit For Mask Administration to One Patient."

MANIFOLD FLOWPORT - With regulator handwheel loose, remove cap screw (4436) and gasket (7-150). With small screw driver remove flowport (6009-SA) also gasket (7-127). Clean out flowport with non-inflammable cleaner fluid. (Preferably put in new one.) Reassemble all parts tightly.

MANIFOLD OUTLET VALVE - Screw off hex body (22690-SA). Drop out spring (22696) and valve (22695). Examine molded gasket seat (7-158-1). If damaged put in new one. With screw driver remove limit port (22692-2), from which with knife blade remove retainer ring (22337) and screen (22678) and clean these parts with non-inflammable cleaner fluid. Examine limit port gasket (7-157). If damaged put in new one. Screw in limit port tightly and reassemble all parts.

FLOWMETER - Proceed as described under "Oxygen Therapy Outfit For Mask Administration To One Patient."

MASK-BAG-TUBING ASSEMBLY - Nasal (26092-2A), Oronasal (26096-2A).

Mask, nasal (26092-1A), oronasal (26096-1A), bag (139-1A) and tubing (26003-1) should be replaced with new.

HEIDBRINK CLOSED CIRCUIT OXYGEN THERAPY APPARATUS

GENERAL DESCRIPTION - Apparatus is closed circuit type designed for the therapeutic use of oxygen concentrations up to 100%. Shell natron in circuit absorbs carbon dioxide and moisture exhaled by patient. Adapters supplied permit use of all sizes of standard medical and commercial oxygen tanks. Wrenches for the union nut of reducing valve, adapters and small tank valves are supplies. The screw driver is for uncapping can.

ASSEMBLY - Note instructions for assembly and operation pasted inside case cover. Remove case cover turn up-side-down, clamp apparatus on top. Note how packed with reducing valve 4 attached to stud 26, adapter 21 on stud 27 and yoke adapter 22 on block O.

Connect tubings 14 to valves 2 and 9 and Y 16, to which also connect tubing 17 or 18 with mask A or B. Attach bag 13 by metal "L" 10 to valve 9. For fractional rebreathing connect tubing of Mask C to end E of tubing 12. Catheter D connects at F.

Reducing valve 4 which fits large medical tanks is connected by tubing 19 to control valve 25. Use adapter 21 for large commercial tanks or yoke adapter 22 for small medical tanks of H.

To attach natron can 5, pry out metal sealing cap on each side with screw driver and put can in so gasket Y connection 6 and gasket L connection 23 extend into can

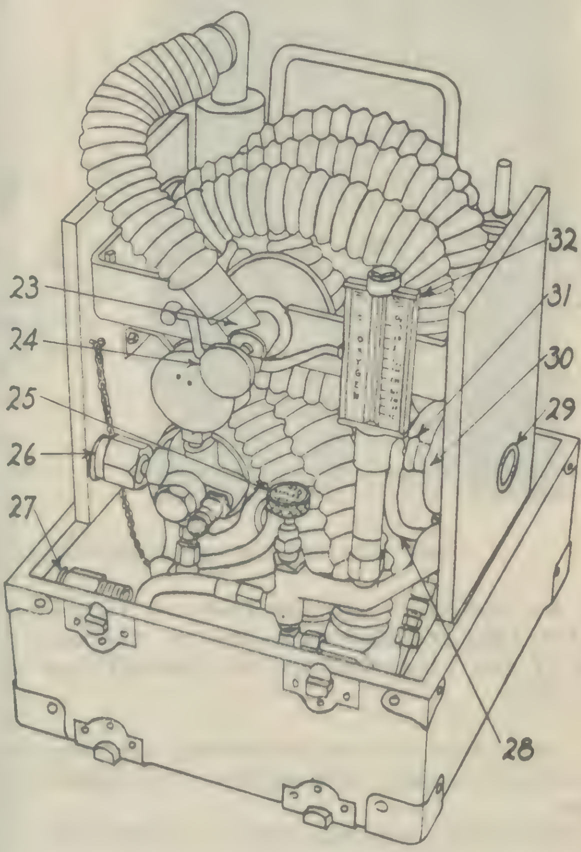
openings and tighten to place with bracket thumb-screw 24.

DESCRIPTION - Oxygen from reducing valve 4 goes through tubing 19 to flowmeter 32 having control valve 25, thence through tubing 28 to valve 9 and bag 13; also to demand valve 30, thence through tubing 31 to Y connector 6 and can 5. Valve 30 automatically opens on approximately 2 cm. H_2O negative (inspirational) pressure and by finger pressure at 29 supplies emergency oxygen.

Expirations pass through valve 2, by tubing 3 through L 23 and can 5, then by tubing 7 to bag 13 and through valve 9 to the mask for inhalation. Valves 2 and 9 are removable and separable without tools for cleaning. Whistle 8 warns when oxygen supply is exhausted or not turned on. Valve 1 opens automatically to release excessive pressure in breathing circuit.

Masks A and B are held in place by harness G which is put on with its elastic strap forward and on top of head. Strap 15 goes around the neck.

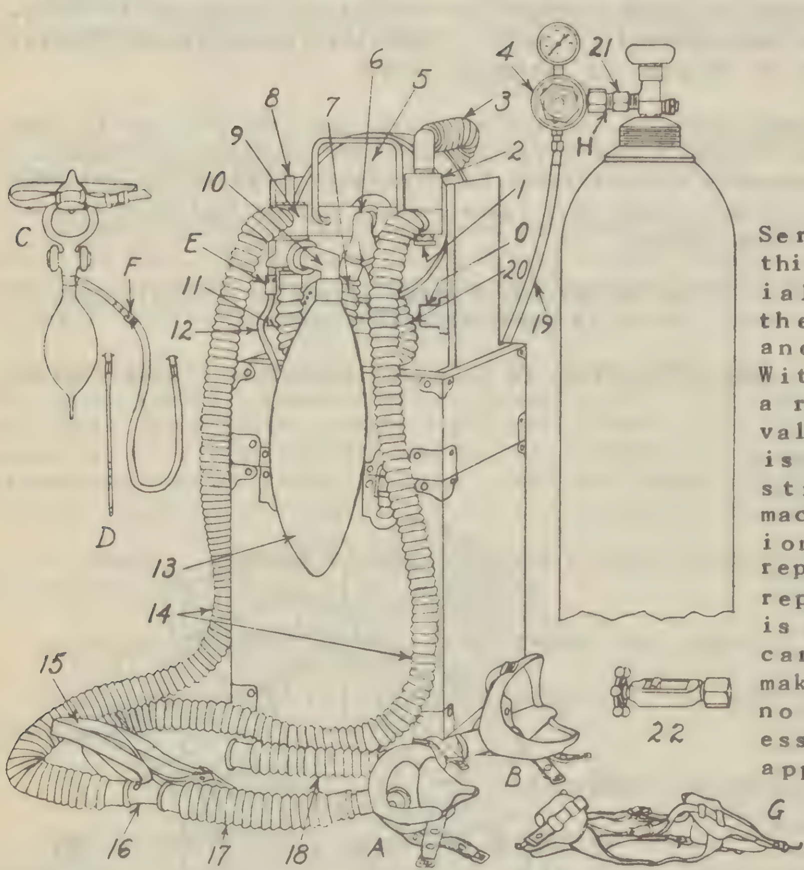
OPERATION - Grip and close off tubings 14 near mask with hand. Open control valve 25 to about 15 liters per minute. When bag becomes completely distended loosen grip on tubings and press bag to empty it. Repeat three times, then when bag is again full apply mask. Reduce the oxygen flow to one liter per minute. Adjust neck and harness straps so mask is COMFORTABLE and air-tight. If bar collapses on inspiration there is leakage around mask rim. If the bag distends unduly, reduce oxygen flow so bag is normally distended on expiration and not collapsed on inspiration. Occasionally remove mask, wipe out, dust face with talcum.



Eight-inch tubing 17 provides for less rebreathing and stimulation by CO_2 than 10-inch tubing 18.

Using 1 liter per minute oxygen a can of fresh natron should maintain CO_2 content normal and relative humidity below 30% for 5 to 6 hours and for 1 to 2 additional hours the CO_2 content not higher then 2 1/2% and re-

lative humidity below 80%, both tolerable. Using less than 1 l.p.m. oxygen the life of the natron is shortened. NATRON IS CAUSTIC---DO NOT SPILL.



SERVICE INSTRUCTIONS - Service instructions on this apparatus are essentially the same as with the closed system gas anesthesia apparatus. With this unit there is a regulator that may need valve seat repairs. This is covered in your instructions on the gas machine as are instructions for the flowmeter repair, needle valve seat repair, etc. Since this is a closed circuit unit, care should be taken to make sure that there are no leaks, otherwise the essential purpose of the apparatus is defeated.

THE HEIDBRINK OROPHARYNGEAL CATHETER OUTFIT NO. 11

The Outfit is shipped from the factory completely assembled except for attaching the tank pressure Regulator to the supply tank, and attaching the outlet on the rear of the flowmeter to the humidifying jar by means of the long rubber tubing provided.

The large nut for attaching the Regulator to the supply tank is threaded to fit medical oxygen tank valves. An adapter for industrial tank valves also is provided.

After the tank pressure Regulator has been tightly attached to the supply tank (using a wrench) and the tank valve is opened, the gas immediately passes into the regulator, and is released therefrom by turning the thumb screw at the bottom of the flowmeter

HEIDBRINK OROPHARYNGEAL CATHETER
OUTFIT NO. 11

The amount of gas thus released which then passes into the flowmeter is registered on the dial of the flowmeter in terms of liters per minute of flow.

A short rubber tubing conducts the gas from the upper rear outlet of the flowmeter to the inlet of the humidifying jar. The continuation of this inlet is the metal tube with perforated "foot" which extends down into this jar.

The humidifying jar should be filled two-thirds full of distilled water.

The "foot" breaks up the oxygen so that it can take up the maximum amount of moisture as it bubbles through the water.

The gas is then conducted by a short tubing from the outlet of the humidifying jar to the inlet of the drip jar. The continuation of this inlet is the short metal tubing which extends into the jar.

Drippings must always be emptied out before they reach the lower end of the metal tube, otherwise water would be forced into the patient's nose and throat.

A long rubber tubing connects the outlet of the drip jar to the nasal catheter by means of the adapter provided.

Outfit is calibrated for the use of either pure oxygen or 80%-20% helium-oxygen mixture.

When jar covers are removed, dip the rubber gaskets in glycerine (dangerous to use vaseline or oil) to assist the covers to seal tightly and prevent leaks.

Before placing the catheter for administration, test the apparatus to determine that the catheter is large enough to deliver the amount of oxygen desired, if other than the catheter supplied is used.

To take the Outfit apart remove the thumb nut under the handle. The top then lifts off and all parts are accessible.

Ordinary Ball Ideal fruit jars are used for jar replacement.

Use urethral catheter size 10-14 French with four or five extra holes in the terminal half inch. (A red hot safety pin passed through the walls makes suitable holes.) These holes prevent the gas from striking only one spot and unduly irritating the membrane of the pharynx.

Great care must be exercised in placing and fixing the catheter so that it does not seriously interfer with speech, breathing, or the swallowing of food; and so that it will remain in place and deliver the gas into the oral (not naso) pharynx.

"Determine the approximate depth to which the catheter is to be inserted by measuring off the distance on the catheter between the tragus of the ear and the external nares. This distance will be the approximate depth and may be marked on the catheter with a small piece of adhesive tape. The catheter is lubricated with Petrolatum U.S.P. (Vaseline) and is ready for insertion. Open cylinder valve wide and start Oxygen flowing by turning the adjusting screw of the flowmeter to the left until flowmeter shows the desired flow rate. The catheter is now carefully introduced to the previously marked depth. If the catheter has been placed carefully, swallowing reflex will be greatly diminished. The most accurate method of determining correct placement of the catheter is to insert it beyond the pre-determined

depth until the patient is seen to swallow a bolus of Oxygen. Then, withdraw it to just the point where swallowing is no longer observed.

With adhesive strips fix the catheter to the patient's face, and mark the catheter where it passes the exterior nares as a guide to proper placing of a fresh catheter in the alternate nostril at twelve hour intervals.

With adhesive strips also fix the connecting tubing to the pillow, leaving enough slack to permit reasonable movement of the head without "pull" on the catheter.

"When the clinical progress has reached such a point that the necessity for excess oxygen in the inspired atmosphere appears to be no longer indicated, fifteen minute readings of the pulse rate are again instituted, accompanied by gradual small reductions in the concentration of oxygen. Whenever the pulse rate tends to increase, the concentration of oxygen must again be raised. So over a period of from twenty-four to forty-eight hours in the usual case sometimes more rapidly, oxygen therapy should be gradually discontinued."

Delivery of not exceeding 7 liters of oxygen per minute will maintain concentrations in excess of 50 per cent.

SERVICE INSTRUCTIONS ON THE OROPHARYNGEAL CATHETER OUTFIT - This unit operates with a regulator. Repair to the regulator seat, needle valve seat and the flowmeter is the same repair instruction given on other Heidbrink Oxygen Therapy equipment.

The channels through the light-weight metal covers to the mason jars are sizable and should not become obstructed. However, should the oxygen not bubble in the jar containing the perforated stone ball when the gas is turned on, this would indicate some obstruction of that line.

If the gas is bubbling in the previously mentioned jar and appears not to be coming through the catheter, that would indicate there was some obstruction after the oxygen leaves the first jar. Probing the oxygen channel in the metal cover with a malleable wire should loosen the obstructing material. If clean distilled water is used, no obstruction will occur.

CHAPTER VI

RESUSCITATION

DEFINITION - Restoration to life of one apparently dead.

The prime immediate need in resuscitation is to get oxygen into the lungs and to remove the inert nitrogen and carbon dioxide.

Method of Resuscitation:

1. Mechanical apparatus
2. Artificial respiration
3. Mouth to mouth breathing

Conditions where resuscitation is indicated:

1. Drowning
2. Inhalation of poisonous or irritating gases.
3. Mechanical obstruction
4. Shock
5. Disease (Infantile Paralysis)

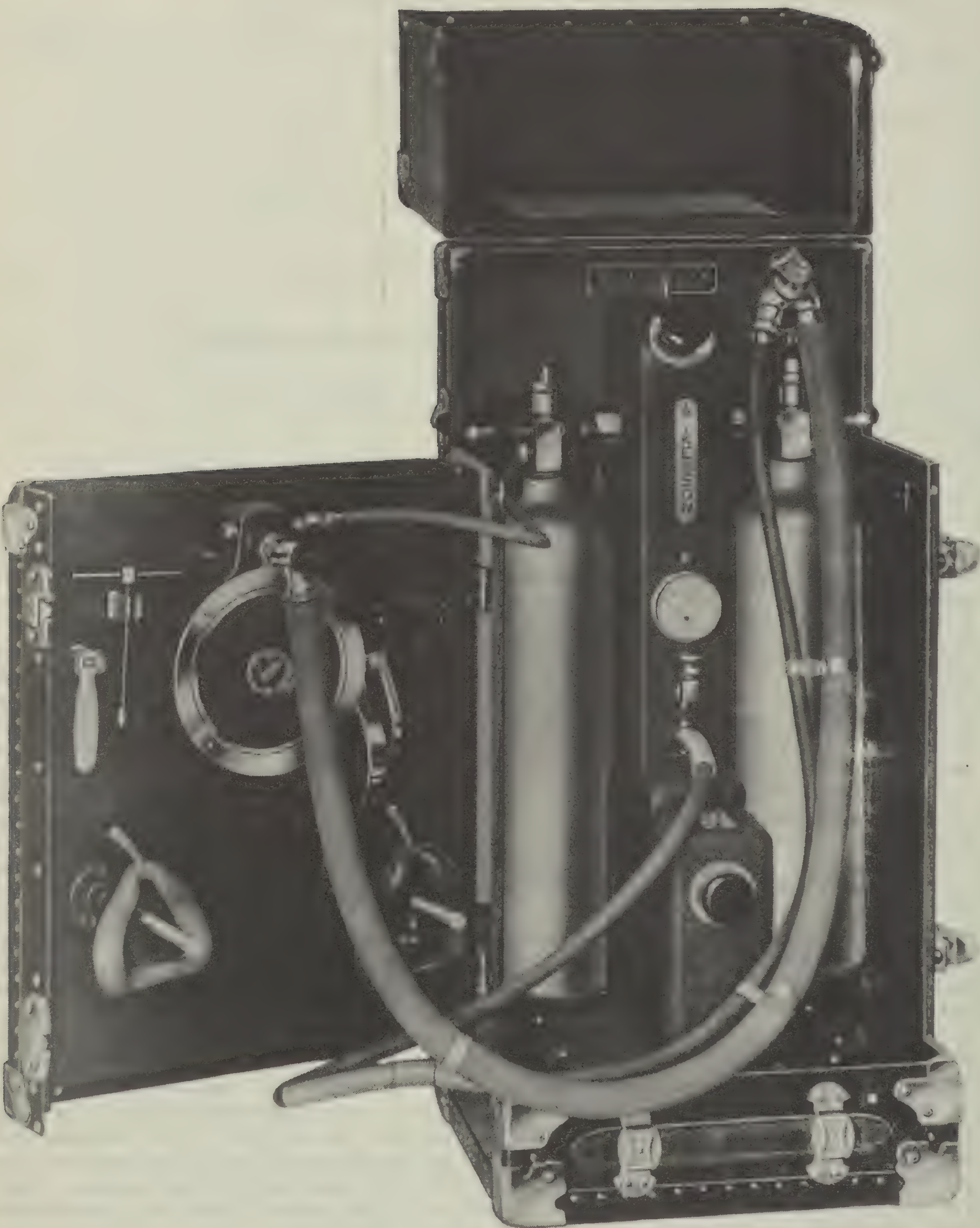
Gases used for resuscitation:

1. Oxygen
2. Oxygen and carbon dioxide mixture.

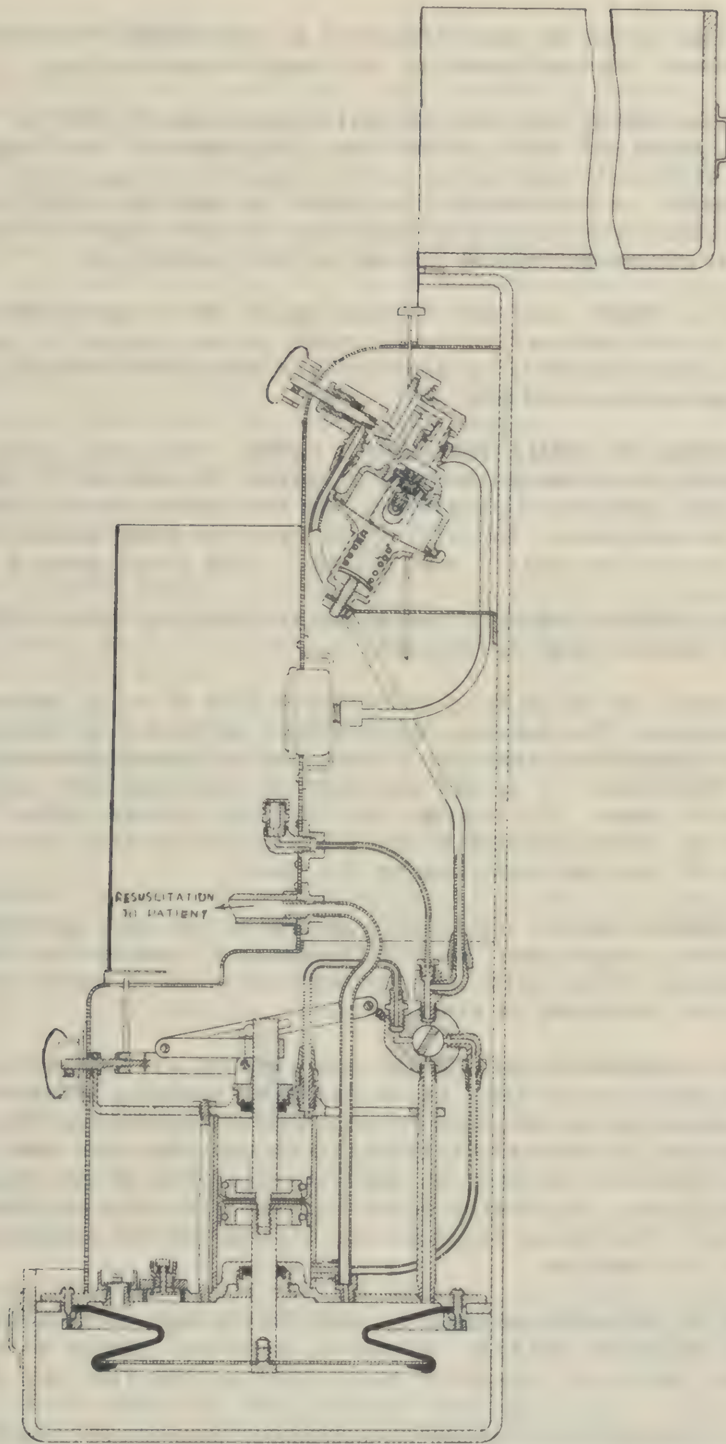
INSTRUCTIONS FOR OPERATING McKESSON PORTABLE RESUSCITATOR MODEL #437 - The portable model is built in a carrying case and is intended to accommodate either B or D standard medicinal cylinders. The operator may use his choice of Oxygen in both cylinders, a mixture of Carbon Dioxide and Oxygen in both cylinders, or a combination of one cylinder of each. NEVER USE PURE CARBON DIOXIDE WITH ANY OF THESE UNITS. Always be sure it is diluted with at least 90 percent Oxygen in the cylinder itself. When using the machine as a Resuscitator, pure Oxygen is ordinarily satisfactory, since the machine does a certain amount of rebreathing thus accumulating some of the patient's exhaled Carbon Dioxide. When used as an Inhalator, pure Oxygen is satisfactory. However, if the patient's breathing has become depressed, the mixture of Carbon Dioxide-Oxygen would be much better. This mixture would cause the patient to breathe deeper. The mixture gas should not be used over a prolonged period. As soon as the patient seems to be breathing normally, pure Oxygen should be administered until all danger has passed

RESUSCITATION RATE CONTROL - The Resuscitation unit in all of these models is exactly the same, however, they are arranged differently in the different models. You will notice two black control knobs, the upper one is labeled "Resuscitation Rate". This knob is a needle valve, which controls the rate or speed of the Resuscitation pump bellows arrangement. By turning this knob to the left, the pump operation will be speeded up. This knob should ordinarily be set so the pump operates at about 15 respirations per minute, which will require about 30 trips of the unit to get 15 full respirations. If only the Inhalation side of the machine is needed, the resuscitation side of the unit can be cut off by turning this valve, and should not be turned off with too much force. For storage, the knob should be set so the pump is operating at about 15 respirations per minute. While set in this way, the *tank* should be turned off. The Resuscitator will immediately start operating at 15 respirations per minute as soon as the tank is turned back on.

THE VOLUME CONTROL- The lower control knob is labeled "Volume Control". Some machines are built without this control. When this control is furnished, it is designed to change the volume of breathing from adult volume to infant volume.



McKESSON PORTABLE RESUSCITATOR
OPEN VIEW



SECTIONAL DIAGRAM OF
McKESSON PORTABLE RESUSCITATOR #437

The red hand just above the knob indicates at what Volume the machine is set. When the knob is turned, the hand moves to the proper volume setting.

When set at ADULT, the unit delivers approximately 100 cc. (about 1 quart), and withdraws about 600 cc. In this way progressively more Oxygen is delivered to the lungs with each respiration until a positive pressure is built up equivalent to the number of millimeters for which the exhaling valve (Pressure Breaker) is set. From then on (as long as the mask is held tightly) the exhaling valve lets the excess oxygen pop off at the end of each exhalation.

When set at INFANT, the unit delivers about 300 cc and withdraws about 175 cc. If your unit is not equipped with adjustable volume control it is still perfectly adaptable to infants as well as adults. The adjustable Volume Control uses less Oxygen when operated on infants.

RESUSCITATION TO INHALATION-CONTROL LEVER - When this lever is set at "RES" the Resuscitator is operating and the Inhalator is shut off. When this lever is set at "INH" the inhalator is operating and the resuscitator is shut off as far as the patient is concerned. You will still hear the pump operating but the Oxygen is escaping inside the unit. For storage, this lever should be set at "RES".

PRESSURE LIMITING VALVE - The pressure limiting valve is the valve in the chimney of the Inhaler body at the mask.

A small wheel on the side is graduated 0-5-10-20 which represents millimeters of mercury pressure. The pressure on this dial may be set as low as "0", but should it be set at a figure more than 20, a second valve (excess pressure) inside the unit will open. Therefore, it is NOT possible to build up more than 20 mm pressure in the patient's lungs. For storage the "Pressure Breaker Valve" (Exhaling valve) should be set at about "5". With the machine set in this way while the pump is working, turn off the tank and close up the case.

VACUUM BREAKER VALVE - This valve is inside the unit and opens at a very low vacuum (negative) resistance. Should the patient "swallow his tongue" or have an airway obstruction of any sort, the vacuum breaker valve opens up with a whistling noise to warn you something is wrong.

SUCTION ATTACHMENT (ASPIRATOR) - A suction attachment is furnished with Resuscitators when specified. It is used for removing mucus or water from the throat. By pressing on the cutoff lever (at the handpiece that attaches to the bottle) a suction is created at the tip, at any time the tank valve is opened. This suction continues as long as the lever is pressed and stops when you take thumb off the lever. A liberal sized bottle is furnished, however should this bottle overfill, the excess would go out the top of the aspirator. No mucus can be drawn into the machine.

A. HOW TO OPERATE MACHINE IF PATIENT IS NOT BREATHING - EXAMINE MOUTH FOR MUCUS OR EXCESSIVE SALIVA. If any is present, remove with aspirator. If you don't have aspirator turn patient's head to the side and down if possible.

Place a wooden wedge or something similar between the teeth to the side of the cheek in order to assure the patient's mouth remaining open for the following procedure; if the jaws are not wedged in this fashion sudden reflexes or recovery of the patient may result in the operators fingers being seriously injured when the teeth come together. Should the jaws be set and the tongue obstructing. it will be necessary to pry the mouth open. This should be done with utmost care so

that the teeth are not broken.

Wrap handkerchief over forefinger, pull patient's tongue forward and wipe out mouth and throat with finger. While holding patient's tongue forward, put metal airway on top of tongue letting it barely extend into throat.

B. HAVE PATIENT ON HIS BACK AND HOLD CHIN WELL UP. Turn tank valve ON and apply mask lightly to patient's face, placing the narrowest end of the mask WELL UP on the hard part of patient's nose. Be sure lever on inhaler body is turned to "RES" and exhaling valve at 5 or more. The speed of the pump should be operating about 15 respirations (30 trips) per minute.

C. WATCH THE PATIENT'S CHEST. Be sure it is breathing rhythmically with the machine. If it isn't, be sure chin is WELL UP, increase pressure on exhaling valve, if necessary remove mask and recheck for Mucus.

D. IF FOR ANY REASON THE PUMP STOPS, CHECK TANK PRESSURE GAUGE. If the tank is empty turn on the other tank. If the tank isn't empty move the tripping device at top of the machine.

IF PATIENT IS BREATHING - Even though the patient is unconscious, if he is breathing the resuscitator (artificial respiration) is NOT indicated. This would be true in starting a patient as well as after the patient's reflexes (not necessarily consciousness) return.

If the patient is breathing of his own accord, set inhaler body lever at "INH" and exhaling valve at "0". This will allow him to breathe any volume required, but will supply him with oxygen.

RESUSCITATOR SERVICE SUGGESTIONS

IF THE PRESSURE SETTING WHEEL ON EXHALING VALVE DOES NOT REMAIN STATIONARY ON PRESSURE DESIRED - This exhaling valve is on the inhaler body, that is, the mask chimney. The adjusting ring screw for this, is on the opposite end of the axle from the pressure setting wheel. Use a knife blade to turn this screw a fraction of a turn to the left (counter clockwise).

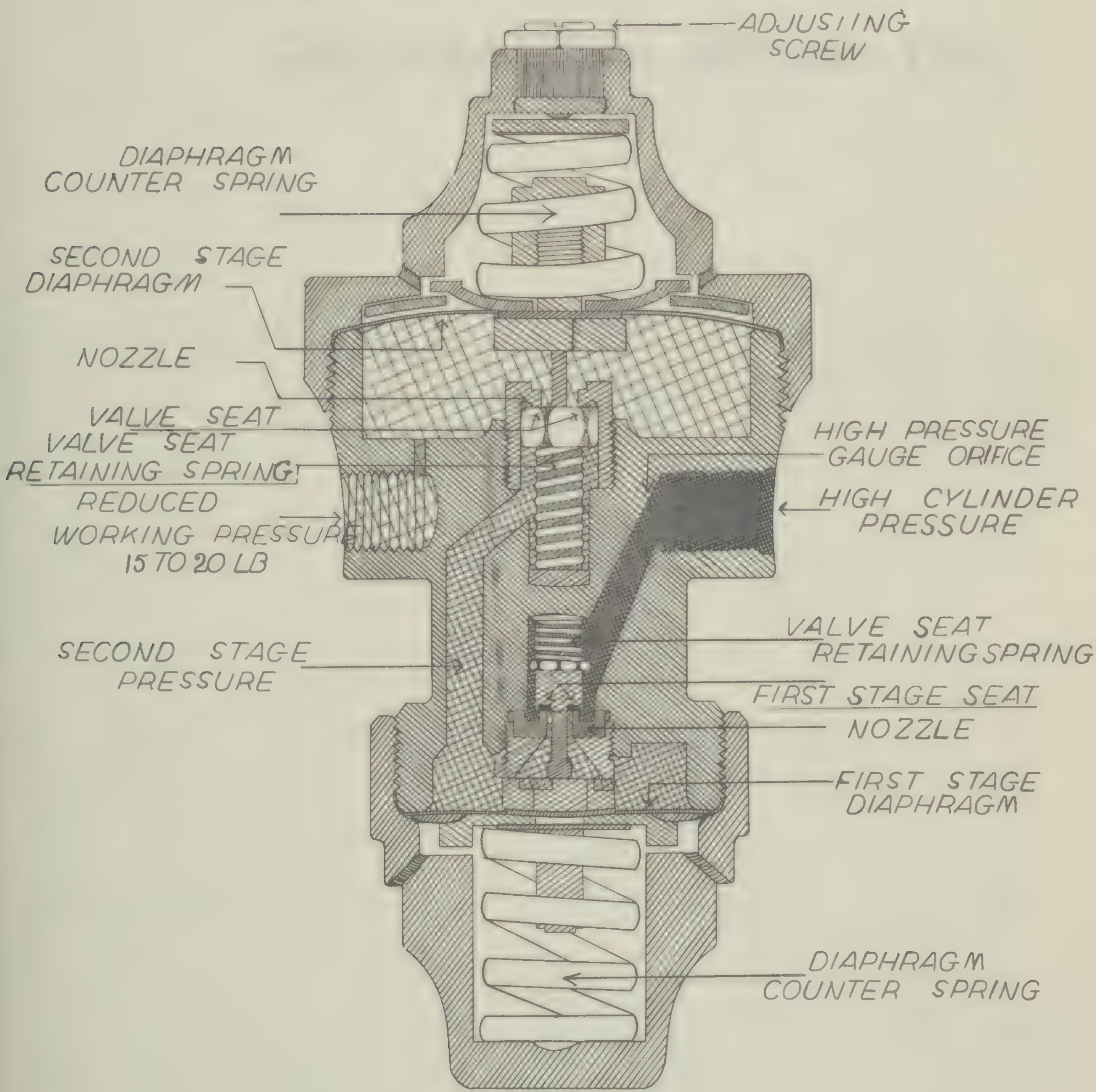
IF COMPLETE EXHALING VALVE 822 GETS LOOSE IN INHALER BODY - This valve is supposed to revolve fairly free on the inhaler body, but if it gets so loose a leak occurs, put wide bladed screwdriver up through inhaler body and while holding it against the inner part of the exhaling valve, unscrew the exhaling valve with fingers. Remove the large hollow screw which screw driver was holding. You will find a thin metal spring washer over this screw. Bend this washer so it will create more tension on leather gasket.

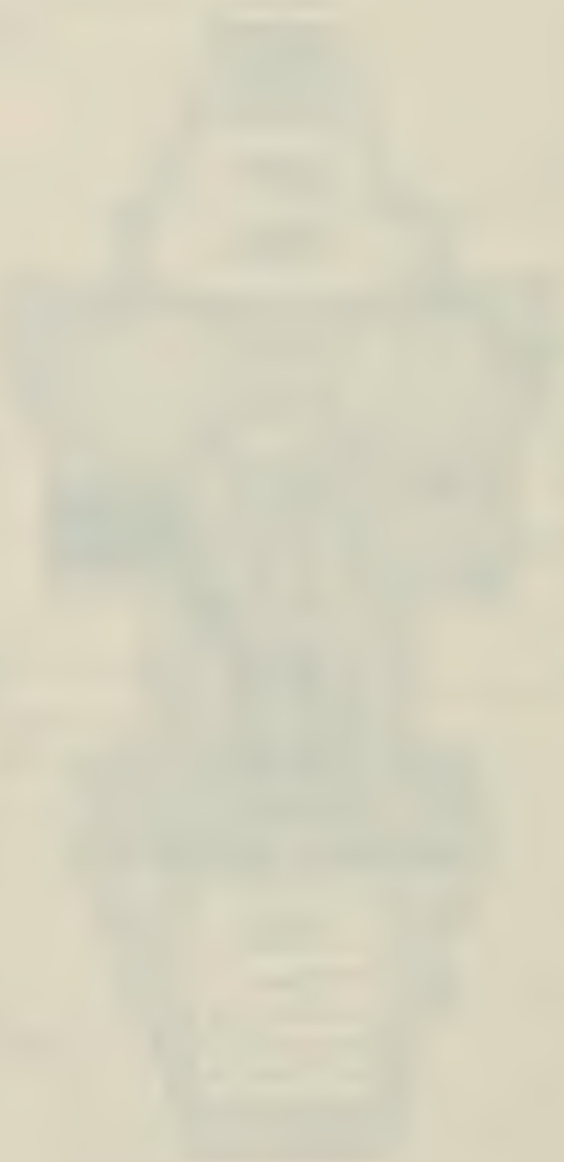
IF LEVER THAT OPERATES RESUSCITATOR TO INHALING VALVE IS TOO STIFF - Put some oil through the slot and inside the inhaler body and work lever back and forth.

IF PRESSURE LEAKS FROM ONE TANK THROUGH THE OTHER YOKE - This can be corrected by tightening the hexagon nut that attaches the regulator to the yoke assembly. If it does not, unscrew this nut and remove the screws from the back that holds the yoke into the case. Clean the check valve and replace.

HOW TO OIL RESUSCITATOR - Remove the round cap on top of pump assembly, stamped OIL. Use thin oil. Do not try to run the machine until you have replaced the cap. Do not try to oil it while resuscitator portion is in operation.

TWO STAGE PRESSURE REDUCING REGULATOR FOR "EMERSON RESUSCITATOR"





CHAPTER VII

GAS ANALYSIS APPARATUS


HAYS

GAS ANALYSIS APPARATUS

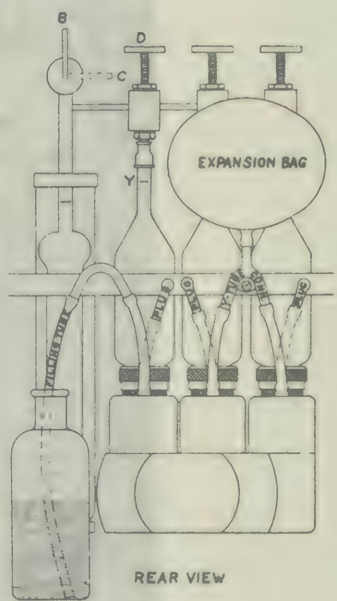
DIRECTIONS FOR THE USE AND CARE OF GAS ANALYSIS APPARATUS NO. 380 (HAYS)

INTRODUCTION - The apparatus is designed to measure the percent of oxygen and carbon dioxide in oxygen therapy tents for which it has been specifically constructed. The analysis of both gases is quickly and accurately made by following the directions.

PURPOSE OF TENT ANALYSIS - For intelligent use of oxygen therapy apparatus, analysis of the gases is necessary since the various factors which influence the concentration of oxygen in a tent may be discovered and corrected. For Example: the tent may be applied to the bed so that it holds oxygen badly, analysis shows this error. The tent may or may not be effective in eliminating carbon dioxide without the use of the carbon dioxide absorber. Analysis shows this too, particularly when administering mixtures of carbon dioxide and oxygen after operations, in fact, any case where carbon dioxide and oxygen is to be given to a patient--it is usually necessary to so regulate the flow of these gases into the tent that a certain definite percent of carbon dioxide is present in the tent for respiration.

The use of this gas analyzer removes doubt regarding the concentrations of these gases and definitely aids the doctor in his use of oxygen therapy by knowing what concentrations were actually taken by the patient.

TO FILL APPARATUS WITH SOLUTIONS (See Rear View) - Remove rubber tube from the plug on the crossbar and insert the bent copper tube, which is furnished with each analyzer, as illustrated. Remove stopper from bottle of carbon dioxide absorbing solution and insert rubber filling tube (which is attached to the bent copper tube), to the bottom of the bottle. Fill the leveling bottle with water and set it down in front of analyzer. Be sure that all needle valves are closed. The solution is pumped into the hard rubber container as follows: Turn cock handle to position B and raise leveling bottle until water bubbles through the hole in the top of the cock. Turn cock to position C. Lower leveling bottle and open valve D. When water level is at zero close D and turn cock to position B and again raise bottle until water bubbles out at top. Turn cock to C, open needle valve D, and lower leveling bottle slowly, watching solution rise in the steel wool filled chamber until the chemical reaches the etched line Y. When chemical reaches Y turn cock handle to B and the chemical will fall into the hard rubber container. Close the needle valve D and raise leveling bottle until water again bubbles through the opening in cock. Turn cock to position C, and open needle valve D. Lower leveling bottle slowly, watching chemical again rise in steel wool filled chamber. When the chemical reaches the etched line Y close the needle valve D. If it does not reach the etched line turn cock to B and raise leveling bottle until water bubbles out opening at top, then turn cock to C. Open valve D and lower leveling bottle until chemical reaches Y and then close needle valve. Remove the bent copper tube and the carbon dioxide absorbing chamber is now ready for use.



REAR VIEW

Wash filling tube with water before filling the oxygen chamber with Seez O_2.

Follow the preceding directions very carefully using "Seez O_2" to fill the second chamber. After completing the preceding directions insert the rubber tube on the Y tube connection to which is connected an expansion bag. Fasten the rubber tube from the third absorber to the other leg of the Y tube to the bag. Raise one side of the rubber cap just below the cock and fill the water jacket with clear water. The analyzer is now ready for use.

When not using the analyzer, the solutions should be dropped down into the containers by turning the cock handle to B and opening each needle valve. After the solutions are in the chambers close needle valves and connect the rubber tubes which are attached to the cross bar to keep fluid from spilling when the apparatus is in any position for transportation or storage.

TO MAKE ANALYSIS FOR CARBON DIOXIDE AND OXYGEN - After filling the absorption chambers with their respective solutions as above described then disconnect the rubber tube from the plug in the back on the carbon dioxide absorber, also the tube for the oxygen absorber, but connect the latter to the connection to the bag, (and either stopper the other limb of the Y tube to the bag, or connect it to the spare chamber also containing Seez O_2 if one is provided). Then bring the absorption fluids to the top of the glass absorption bulbs--the etched lines marked Y and Z in the drawings as previously described. Unless the rubber tubes are removed from the plugs the fluids will not rise in the absorption bulbs. The bag employed is to prevent air from reaching the "Seez O_2" which would soon saturate the solution and render it unfit for analyses. Seez O_2 changes from purple to brown when exhausted. (The spare absorption chamber is then used for oxygen absorption in those instruments provided with three, in the same manner as described below, thus saving time of cleaning and refilling during work.) Use only one oxygen absorber at a time.

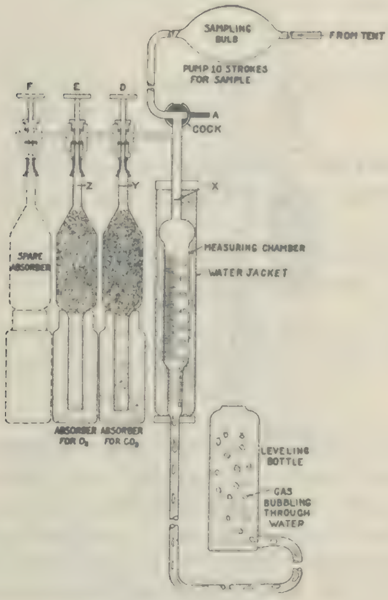


Illustration No. 1

Pumping sample into Analyzer

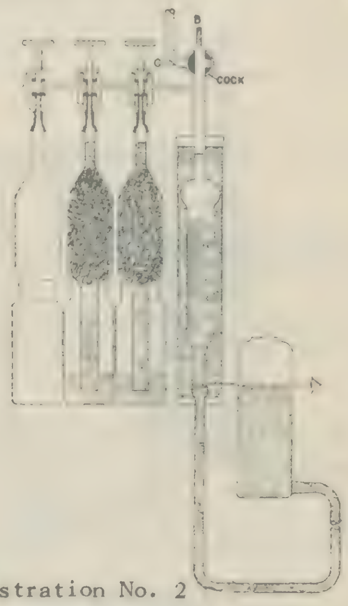


Illustration No. 2

Turn cock to B
Raise water level to zero
Turn cock to C

See that the bag contains enough air to permit Seez O_2 to rise in the glass absorption bulb to the etched line.

Illustration 1 - Turn cock handle to position A and lower leveling bottle until the water level is below zero. Pump sample into analyzer by squeezing the sampling bulb several times. By pumping ten strokes you are assured that the sample in the analyzer is a true sample of gas from the tent. While squeezing the sampling bulb air can be seen bubbling through the water in the leveling bottle.

Illustration 2 - After pumping the sample into the analyzer turn the cock handle to B, raise the leveling bottle until the water level in the bottle is level with the water in the burette at zero. Don't move it up and down but slowly up to zero. Immediately turn cock to C. The sample is now ready for analysis. (The carbon dioxide is first absorbed and measured, then the oxygen is removed and measured as follows:)

Illustration 3 - Open valve D and raise leveling bottle until the water level is at X. Leave sample in carbon dioxide absorber for about 10 seconds and then (Illustration 4) lower leveling bottle slowly, watching the solution raise, stop it at Y. When solution is at Y close valve D, level the bottle and read the percent of carbon dioxide on the scale on the measuring burette. Again open valve D and return gas to carbon dioxide absorbing chamber and back to measuring chamber, as before repeating until all carbon dioxide is absorbed--giving a constant reading for two measurements. This is the carbon dioxide percentage. In the drawing it was 1%.

Illustration 5 - Open valve E and raise leveling bottle until the water level is at X. Leave sample in oxygen absorber for about 30 seconds and then (Illustration 6) lower the leveling bottle *slowly*, watching that the Seez O_2 solution is

Illustration No. 3
Open Valve D
Raise Water Level to X
Absorb CO_2

Illustration No. 4
Raise Solution to Y
Level Bottle and Read % of CO_2

stopped at Z. Close valve E, raise bottle until the water is level with water in measuring chamber and read the burette. Repeat 5 and 6 until a constant reading is obtained, that is, until all the oxygen is absorbed. In this case the reading was 61%, which represents the amount of oxygen plus the amount of carbon dioxide. In Illustration 4 1% carbon dioxide was found, therefore, subtract this amount from the total (61%—1% carbon dioxide = 60% oxygen) which leaves 60% oxygen.

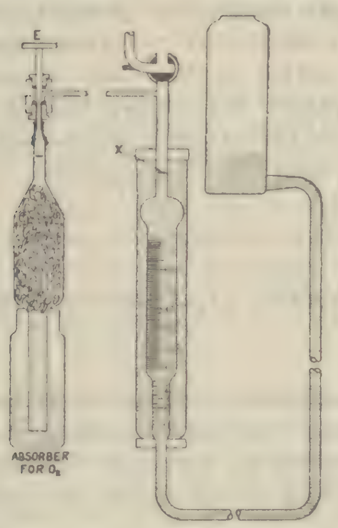


Illustration No. 5
Open Valve E
Raise Water Level to X
Absorb Oxygen

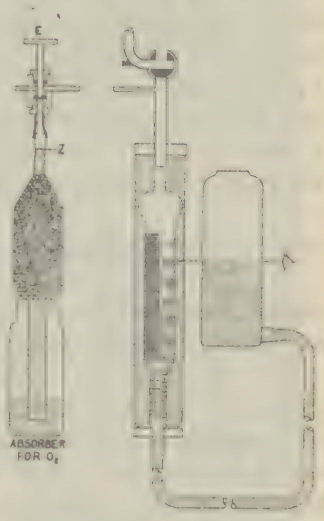


Illustration No. 6
Raise Solution To Z
Close Valve E
Level Water and Read Burette
Total-CO_2% = O_2%
Example: 61-1(Ill. 6) = 60% O_2

From this analysis it was determined that the air in the tent contained 60% oxygen and 1% carbon dioxide.

It is always necessary to remove the carbon dioxide first as the Seez O_2 absorbs oxygen and also absorbs carbon dioxide.

NOTICE - Keep a fresh charge of chemicals on hand. The carbon dioxide solution is good for 400 analyses. Seez O_2 solution can be used for 200 analyses.

For better visibility of the chemicals when making analyses in a dark place you can place a piece of white paper back of the small glass tubes below the needle valves.

GENERAL INSTRUCTIONS - If water "jumps" up and down in the measuring burette when using the aspirator remove the threaded fittings on each end of the aspirator bulb and dry the small rubber plug which you will find in each of these fittings. If this does not eliminate the trouble you can pinch the rubber tube on the analyzer side of the bulb after each aspiration until a good sample has been pumped into the measuring burette. Then let go of the aspirator bulb.

After completing the analyses and when preparing the Analyzer for transporting be sure to replace rubber vent tubes on plugs in rear of chemical containers, turn cock handle toward front of Analyzer, tighten the needle valves, pour water out of

leveling bottle, place this bottle properly in the case so as not to kink rubber tubing, snap the aspirator bulb into its clamp inside the case and wind aspirator tubing around the reel, and close case doors.

When using the leveling bottle, in bringing the gas to zero in the measuring burette and when pushing the gas sample over into the absorption chamber, the operator will find it easier and will experience less danger of overshooting zero or getting water and chemicals mixed by holding the bottle in the hand in such a way that the palm of the hand can be easily pressed against the rubber tubing where it enters the bottle to kink it, thus providing a valve for slowing up movement of the liquids when they approach the point where it is desired to stop them.

Needle valve seats can be easily removed for replacement, using pliers.

The packing nuts at the needle valve stem should be tightened occasionally to prevent leakage around these stems.

The three-way valve plug should be removed occasionally, wiped clean and a thin film of vaseline placed on it. Push a match through the holes to open them after applying the vaseline. Then stretch the spring slightly to increase its tension and assemble the valve. This precaution will prevent leaks in the valve and prolong its life.

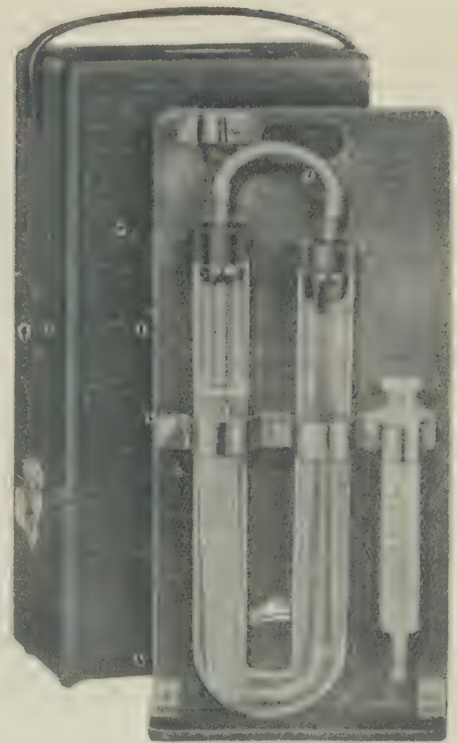
HOW TO CLEAN CHEMICAL CONTAINERS AND REPLACE CHEMICAL SOLUTIONS - The Gas Analyzer can be completely disassembled for cleaning by loosening the one screw at the right side of the flat spring across the horizontal center of the black bottles. Slide this spring to the right until it disengages itself at the left side. Remove the moulded rubber connectors above the glass numbers and remove each chamber and black bottle assembly from the case by pressing at the rear of both the glass and rubber chambers. Pour out the old solution and clean these units with cleansing fluid, replacing them in their proper place in the case as originally installed. It is not necessary to remove the glass chamber from the rubber bottle to clean the Analyzer. Tighten the screw in the flat spring after sliding this spring firmly into place. Fill with fresh chemicals.

If necessary to clean the manifold below the case top, remove cleanout screw at the left end and use a pipe cleaner or wire. Replace the screw and gasket tightly.

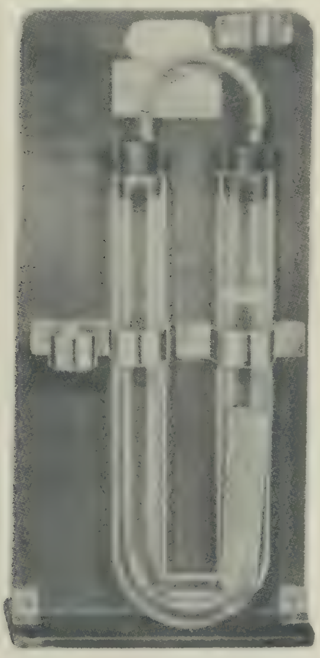
OHIO ANALYZER (OXYGEN-CARBON DIOXIDE) SUPPLIED WITH HEIDBRINK O_2 TENTS - A compact, easy to use Analyzer for routine analysis of the tent air. Accurate readings of the Oxygen and Carbon Dioxide content are quickly and easily determined from a single sample.

The apparatus consists of two U tubes mounted on opposite sides of a supporting board or rack. The U tube on one side is for the analysis of the Carbon Dioxide content, and the U tube on the other side is for analysis of the Oxygen content. A removable glass syringe is mounted on one side of the board.

One of the U tubes has glass tubing; the other contains a roll of copper screen. The latter is used for the analysis of Oxygen content and is to be filled with a mixture of equal parts of sixty percent (60%) ammonium hydroxide. The U tube with glass tubing is to be filled with a ten percent (10%) potassium hydroxide solution. Care should be taken that both U tubes are filled exactly to the level mark provided. (The chemicals above mentioned are furnished as part of the equipment.)



OHIO ANALYZER
Front view showing syringe and "U" tube for CO_2 analyses.



Rear view showing "U" tube for Oxygen analyses.

Each arm of the U tube is fitted with a rubber stopper, into which has been inserted a small glass tube. When the apparatus is not in use, the length of rubber tubing provided should be kept connected between these two small glass tubes.

Solutions should be changed and mixing chambers thoroughly washed out every three to six months, depending upon the number of times the equipment is used.

TO MAKE ANALYSIS - Analysis for both Carbon Dioxide and Oxygen can be made from a single syringe of air from the tent hood. Insert the tip of the syringe with the plunger depressed into the metal analysis vent on the top of the tent hood. Retract the plunger until a

syringe-full of air has been taken from the hood. Now depress the plunger and discharge that air back into the hood where it will be taken up by the circulation. Repeat this operation twice to be sure that no outside air remains in the syringe. Now take a third sample. With the plunger held carefully in the retracted position at a point just beyond the zero mark, remove the syringe from the analysis vent. Remove the rubber connecting tubing from the glass connector inserted in the U tube for Carbon Dioxide immediately under the syringe clamp. Depress the plunger of the syringe to zero and carefully insert the rubber tubing over the glass connector in the U tube. Inject the contents into the U tube. This will displace the solution in that arm and will cause a corresponding rise of the solution in the opposite arm. Maintain this position for one minute, and retract the syringe plunger until the fluid in the U tube returns to the level mark. The position of the plunger in the syringe will indicate the percentage of Carbon Dioxide in the tent air.

In order to insure accurate readings, it is suggested that the above procedure be repeated until two corresponding readings are obtained.

After the reading for Carbon Dioxide has been obtained and without letting the plunger slip, quickly release the syringe tip and attach it to the glass connector on the one arm of the U tube containing copper located on the opposite side of the board. Inject the remaining air in the syringe into this U tube. Maintain this position for two minutes and retract the plunger until the fluid in the U tube returns to the level mark. Note the percentage indicated on the syringe at the bottom of the plunger. Subtract from this percentage the percentage that was originally obtained from Carbon Dioxide. The result will be the Oxygen percentage.

For example: If the first reading of the syringe was 2%, and the final reading 52%, the 2% would indicate the Carbon Dioxide content of the hood and the difference between 2% and 52%, or 50%, would be the Oxygen percentage.

CHAPTER VIII

FEVER THERAPY CABINETS

SECTION 1

- BURDICK -

FEVER THERAPY CABINETS

INSTALLING AND OPERATING BURDICK FEVER CABINET FTC-2

PREPARATION OF CABINET - The wooden rack is first placed in position, making sure that it is as far toward the head of the cabinet as possible. Next the special hair mattress is placed on the wooden rack, *making sure the slide fastener provided at one end of the mattress is placed at the head end of the cabinet.*

The Burdick cabinet is equipped with a syphon water system humidifier device by which the water is fed from the bottle outside the foot of the cabinet. This bottle is shipped separately. To fill, unscrew cap (use warm tap water) screw cap on tight, carrying the bottle with the attached handle, tip it upside down in the guide way and down against the bottom of the cap holder. Swing handle over the strap at the bottom of the cap holder and lock the bottle in position.

The cap holder is adjusted at the factory to maintain the proper water level in the humidifier pan. Never allow the bottle to become empty as this will shorten the life of the humidifier element and seriously interfere with humidity conditions in the cabinet.

To facilitate draining the humidifier pan a drain plug has been provided at the bottom of this pan. It is advisable to drain this pan occasionally to get rid of the body salts accumulated from the condensation on the cabinet walls. There is also a drain cock provided in the compartment at the head end of the cabinet. This should be drained if possible after each fever treatment to keep the cabinet sanitary.

FUNCTION OF CABINET CONTROLS - Plug in line cord to receptacle at the head end of the cabinet. Four switches are located at head end of the cabinet and are as follows:

1. "Main Switch"
2. "300 Watt Dry Heat Control"
3. "400 Watt Dry Heat Control"
4. "Low-Medium-High Moist Heat Control"

The Main Switch controls the operation of the fan which circulates the moist air through the cabinet. This switch should always be left on during the entire treatment. It also serves as the master switch for the rest of the switches and must be on "ON" position before any other control will function. Switches #2 and #3 control the dry heat elements of the wattages indicated on the plate directly above the switch. These switches are generally both turned on during the pre-heating of the cabinet preparatory to the treatment. Switch #4, designated as moist heat control, regulates the immersion heater located in the water pan for the purpose of creating humidity.

PRE-HEATING FEVER CABINET - The cabinet should always be pre-heated before treatment is begun to insure greater comfort of the patient and to reduce the time consumed to elevate the patient's temperature.

Before the cabinet is pre-heated make all preparations for the patient, such as placing a terry cloth cover over the mattress to serve to absorb the perspiration during the treatment and the moisture from the cabinet. Place the proper pillow on the adjustable head rest and close the head end of the cabinet with one of the terry cloths furnished with the cabinet. See that the rubber sheet is properly tied to the terry cloth. This rubber sheet is placed between the two thicknesses of cloth to prevent the moisture of the cabinet from being transferred into the room. The terry cloth is doubled up and one-half is put in between the cloth rack provided on

the cabinet and doubled over so that the rubber sheet is in between the two cloths when in place.

If excessive moisture is transferred from the cabinet, it is advisable to fold the inner half of the terry cloth inside the cabinet and the other half is kept on the outside of the cabinet. The corners of the cloth can be held in place with the clips provided, one on each side of the cabinet.

Turn #1, or Main Switch, to "ON" position, and also switches #2, 3 and 4 to high positions. This throws all the heat available into the cabinet and will raise the temperature to 120-125° in 30 minutes or less, depending on room temperature. When the cabinet temperature has reached 120° F., as indicated on the thermometer of the cabinet, it may be opened and the patient placed in the cabinet. The opening of the cabinet will, of course, cool it down rapidly so that by the time the patient is in position in the cabinet the cabinet temperature may be lowered to 90 or 100° F., depending upon the length of time it takes to place the patient in the cabinet. By leaving all the switches "ON", the cabinet temperature will quickly rise to the desired level.

OPERATION OF CABINET DURING THE INDUCTION OF FEVER AND MAINTAINING PATIENT'S TEMPERATURE.- The humidity of the cabinet should be kept from 85 to 100 per cent. If this is done it should be possible to raise the patient's temperature up to 106.5° F. with cabinet temperature of 115 to 124° F., and to maintain this temperature with a cabinet temperature of 110 to 115° F.

Patient's temperature may be regulated and maintained by the control of the moist and dry heat switches on the cabinet. The patient's temperature may be lowered by turning off all the heating elements and providing ventilation about the neck; or opening the sliding doors, exposing the arm of the patient.

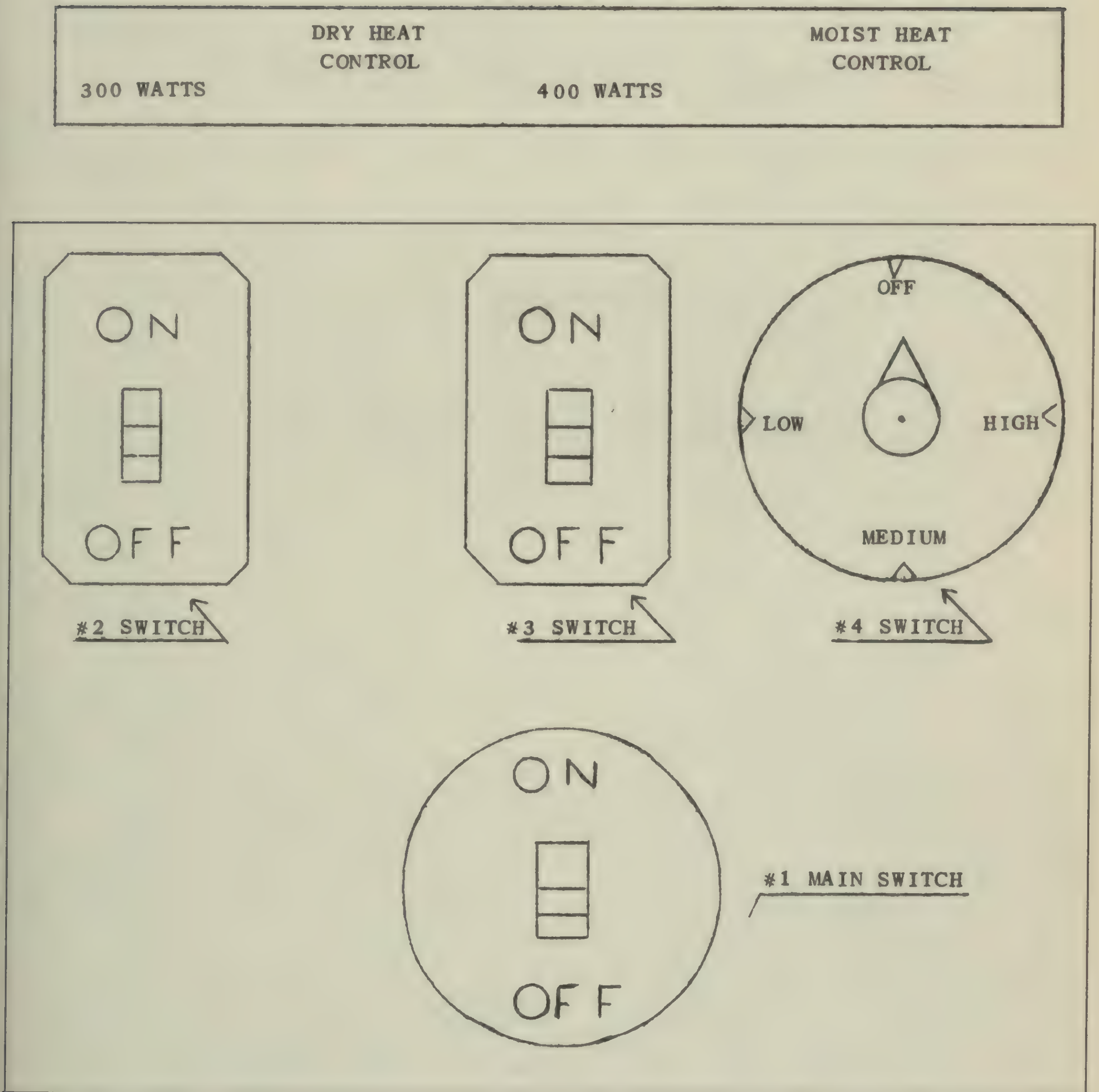
It is advisable to use an electric indicating thermometer, having the bulb remain in the rectum constantly during the entire fever period. With this instrument located at the head end of the cabinet, the attendant nurse can keep constant observation of any variation of rectal temperature.

The sliding doors on each side of the cabinet provide a convenient means of caring for the patient. On the right side the door in the center of the cabinet slides toward the foot end; and the door nearest the head end of the cabinet slides in the same direction, pushing the center door ahead of it. This arrangement provides a maximum size opening when the two shutters are opened apart as far as they will go, and also makes possible the mimimum amount of opening during the time the fever is being induced for obtaining rectal temperatures with a rectal thermometer.

The cabinet is equipped with an adjustable head rest that can be elevated for the most comfortable position of the patient during the fever treatment. The head rest can be dropped by pressing the lock together on the support.

As soon as the patient is removed from the cabinet, the mattress should be removed from the rack and placed in position to dry; and all surfaces of the cabinet should be wiped dry. This will keep the cabinet clean and sanitary. Always leave the cabinet open over night after a fever treatment is given.

CABINET CONTROL BOARD



CHAPTER VIII
FEVER THERAPY CABINETS

SECTION 2

- GENERAL ELECTRIC -

GENERAL ELECTRIC

OPERATION OF G-E FEVER CABINET - In order to elevate the temperature of a patient, it is necessary to prevent excessive loss of heat from the patient, as well as to introduce additional energy into him. The General Electric Fever Cabinet is designed for inducing and maintaining fever. The advantages of this cabinet are:

1. It can be readily cleaned.
2. It provides room for the patient to move.
3. There is no oppressive weight on the patient.
4. The desired temperature is easily produced and maintained by means of circulating, warm, humidified air within the cabinet.

The cabinet is entirely of metal except for the wooden patient's bed support. The fan only of the fan-heater unit operates continuously to maintain adequate circulation. The heating element of the fan-heater unit is controlled by the thermostat and is turned "on and off" as indicated by the pilot light.

The master switch is located on the side of the cabinet. This switch when "on" energizes the line connections to the fan-heater unit, thermostat and immersion heater unit. The switch to the right of the pilot light controls only the interior illuminating lamp.

NOTICE - The fan motor should be oiled once a month.

The humidifier is of the vaporizing type, consisting of an electric immersion heater unit permanently installed in the water pan. The immersion heater is of 1000 watts capacity and is controlled by the three-heat switch mounted at the head end of the cabinet. The warm air from the fan-heater unit and the rising vapor from the water pan is circulated constantly throughout the interior of the cabinet, thereby assuring adequate circulation of warm, humidified air over the patient.

NOTICE - The immersion heater *must* always be covered with water before turning the switch "on". If operated without water, the unit will burn out, necessitating a replacement. The water level must be kept constant for protection of the heater and to provide sufficient vapor.

NOTICE - A baffle plate is attached on the underside of the cover which fits over the water container. The cover must always be placed in position with the baffle plate at the front end next to the fan-heater unit, so that the forced heated air will be directed downward into the water container.

The technic to be followed in administering treatment with the General Electric Fever Cabinet is as follows:

1. Pour sufficient water into humidifier pan through the filler cup to bring the water level up to the red line in the cup. Check water level occasionally during treatment to make sure humidifier is filled. Add water as indicated. Cover mattress first with a rubber sheet and then with the two terry cloth blankets which are included with the cabinet. Secure the blankets in position with the tie strings provided. Close cabinet and place a pillow over the head opening. Turn the master switch on and set thermostat at 120° F. Set humidity heater switch on "high". Allow the heating and humidifying unit to operate until the temperature of the air within the cabinet reaches 120° F. The pre-heating time will vary depending upon room temperature and humidity. Ample time should be allowed (30 minutes or more if necessary) for the pre-heating of the cabinet; this need not be supervised, however, since the thermostat will automatically turn the heater "off" when the cabinet air reaches a temperature of 120° F. The patient is now placed in the cabinet.

2. Close the cabinet and insert the rectal applicator of the G-E Electric Thermometer passing lead to the instrument through the head opening of the cabinet. Record rectal temperature, pulse, and respiration every fifteen minutes. When the desired rectal temperature level is reached, it is of paramount importance that the trend of temperature be under constant supervision. The use of an electric indicating thermometer makes this possible. Place a bath towel over the towel bar and allow the ends to drape over the patient's neck. This will effectively prevent the patient from being forced to breathe the warmed air from the cabinet which might escape around the neck-piece.

3. If the rise in patient's temperature exceeds one degree per 15 minutes, reduce the cabinet temperature by lowering setting on the thermostat. When the rectal temperature of the patient has reached within 1½$^{\circ}$ F. of the desired temperature, reduce the thermostat to 100° F., and humidity switch to "medium". This is to allow for a possible increase in temperature of the patient. If the temperature of the patient does not rise to the desired level, increase the thermostat setting until the proper temperature is attained, adjust temperature of the air within the cabinet by the thermostat control to maintain the desired rectal temperature. Reduce humidity switch to "low". For rectal temperatures of 104° to 105° F., the cabinet temperature should be about 98° to 103° F.; for rectal temperatures of 106° to 107° F., the cabinet temperature should be about 100° to 105° F. In some cases it may be necessary to have somewhat higher air temperatures within the cabinet. The high relative humidity of the cabinet together with its design makes possible the maintenance of fever with relatively low environmental temperatures.

Should it be necessary for any reason to reduce the patient's rectal temperature, proceed as follows: Turn thermostat to 80° F. and open doors on both sides of the cabinet.

5. When terminating the treatment, open cabinet and cover patient with sheet and blanket. When the patient's temperature has fallen to approximately 101° F., transfer patient to hospital bed, give a sponge bath with tepid water, and administer an alcohol rub.

To increase patient's comfort during treatment, it is advisable to circulate air about patient's head by means of an electric fan, rather than to attempt to promote comfort by applying an ice-pack directly to the head.

After patient has been removed from the cabinet, it is important that the interior thereof, be cleaned and wiped dry to protect the metal against tarnish and rust. This can best be done by sponging the interior with clear water and wipe dry. Do not allow excess water to remain on the floor of the cabinet. All water should be flushed into the water container and drained and the floor and pan wiped dry; also leave the cabinet open to air out.

A cabinet equipped with aluminum panels should be cleaned occasionally with Bon Ami. This will help to restore the luster of the metal and prevent tarnish. A cabinet equipped with stainless steel panels should be cleaned occasionally with a good metal polish. A cabinet equipped with enameled panels should be cleaned occasionally with Bon Ami and simonized to preserve the finish.

The bottom chamber of the fever cabinet is of galvanized steel and painted with aluminum bronze for added protection against corrosion. We recommend repainting at least once a year for this protection. The wooden frame, boards and foot board should also be varnished once a year as a protection against moisture.

The mattress is of curled hair and should be protected from moisture as much as possible. The mattress cover is partially water proof. For protection of both, the mattress when in use should be covered with thin rubber sheeting to protect it against perspiration from the patient's body. After a treatment the mattress should be sponged off with clear water without removing the cover and set on edge to permit thorough drying.

When the cabinet is not in use it should be disconnected from the power supply and all switches turned "off". This is to guard against damage should equipment be accidentally left "on" over night.

Two terry cloth blankets are supplied with the cabinet. It is advisable to have extra blankets available if necessary to make a change during treatment or if the equipment is to be used for daily treatments. An extra mattress is recommended so as to alternate between treatments to allow the one previously used to dry thoroughly.

Renewal accessories are listed herewith:

Curled hair mattress 24 x 80 inches
Cover for mattress 24 x 80 inches
Sponge Rubber Collar
Terry cloth blankets with string ties

PRELIMINARY CHECK OF FEVER CABINET OPERATION

1. Ascertain that humidifier pan is filled with water to the level indicated in the filler cup. *Important: Water level must always be kept constant for safety.*

2. Remove mattress and removable boards of mattress support and also metal cover of air duct over humidifier chamber.

3. With humidity heater switch set on "high", thermostat on 110°, and cabinet light "on", turn on master switch and observe whether fan, air heater, water heater, cabinet light, and pilot light operate properly.

4. Turn off all switches and replace air duct cover, removable boards of mattress support and mattress. Take care that cover of air duct is replaced properly as marked; that side sections of mattress support are placed with openings as shown in illustration; and also that terry cloth blankets do not cover these openings. It is important that there be no obstruction to the free circulation of air. If circulation is obstructed, proper operation of the thermostat will be interfered with.

5. Turn "on" master switch only and proceed to check thermostat as described in attached instruction sheet.

TEMPERATURE ADJUSTMENT OF THERMOSTAT OF G-E FEVER CABINET
(For Wilcolator Type Thermostat)

A correctly adjusted thermostat will control the temperature within the cabinet within one or two degrees (plus or minus) of the thermostat setting. With the

thermostat set at 100 it will turn the heater "on" at 98 to 99 degrees and turn it "off" at 100 to 101 degrees. When the heater turns "off" there will be an increase in temperature of approximately one degree. This slow lag cannot be avoided since it is caused by the heat from the heating element before it cools off. Therefore, this slight increase should not be considered when making your adjustment of the thermostat.

Close cabinet and doors; plug up hole in head end with pillow. NOTE: This work to be done without humidity in cabinet.

Set thermostat at 100 degrees.

Turn on master switch. Allow cabinet to heat up to 100 degrees.

Then allow thermostat to open and close heater circuit at least three times before checking with thermometer or re-adjusting thermostat. (This will take about 30 to 45 minutes.)

On the fourth complete operation of the thermostat, quickly read the thermometer when heater is turned "on" and again when heater is turned "off". If thermometer reading is within two degrees of the thermostat setting, do not disturb thermostat setting. If more than two degrees (plus or minus) variation is found, proceed to adjust thermostat as follows:

With thermostat still set at 100 degrees, remove cap screw and slide cap off the shaft of the thermostat.

Loosen (do not remove) set screw on the collar *one turn*, taking care not to turn shaft.

Turn bakelite collar which is now free to rotate without turning shaft, until arrow points to temperature reading on dial, which is the "mean" of the observed "on" and "off" temperatures.

Tighten set screw. Replace cap and screw.

Now set thermostat at 100 degrees and check again by making at least three observations of "on" and "off" temperatures. If "on" and "off" temperatures are within two-degrees of 100 degrees setting, no further adjustment should be attempted.

All other temperature settings will be automatically correct.

The temperature adjustment described is the only adjustment to this type of electric thermostat. Do not open and attempt to change any of the factory adjustments on the contact setting or the stops for the lever action. If after making these adjustments the thermostat does not operate satisfactorily, make a full report to the Officer in charge.

TEMPERATURE ADJUSTMENT OF THERMOSTAT OF G-E FEVER CABINET
(For Dickson Type Thermostat)

A correctly adjusted thermostat will control the temperature within the cabinet within one or two degrees (plus or minus) of the thermostat setting. With the thermostat set at 100 it will turn the heater "on" at 98 to 99 degrees and turn it "off" at 100 to 101 degrees. When the heater turns "off" there will be an increase

in temperature of approximately one degree. This slow lag cannot be avoided since it is caused by the heat from the heating element before it cools off. Therefore, this slight increase should not be considered when making your adjustment of the thermostat.

Close cabinet and doors; plug up hole in head end with pillow.
NOTE: This work to be done without humidity in cabinet.

Set thermostat at 100 degrees.

Turn on master switch and allow cabinet to heat for 45 to 60 minutes.

Inspect cabinet thermometer to see that there is no break in the liquid column or air bubble in the thermometer well.

If the temperature of the cabinet thermometer does not correspond with the setting of the thermostat (100 degrees), reset the thermostat dial as follows:

Loosen set screw holding dial (do not loosen screw on pointer). Move dial in direction necessary so that the reading of the dial will correspond with the temperature reading of the thermometer. Tighten set screw. Check again by making two or three observations of the "on and off" temperatures. If the temperature is within two degrees (plus or minus) of the 100 degrees setting, no further adjustment will be necessary.

All other temperature settings will be correspondingly correct.

The temperature adjustment described above is the only adjustment to this type of electric thermostat. Do not open or attempt to change any of the factory adjustments on the contact setting or the stops for the lever action.

Complete fever therapy installation showing Fever Cabinet, and electric-indicating rectal thermometer.

Lower section of cabinet contains built-in tub of galvanized sheet steel for housing air-conditioning system

View showing air-conditioning system consisting of immersion-type water heater, air heater unit, and electric fan


KEEP WATER LEVEL CONSTANT


MASTER SWITCH
PILOT LIGHT
CABINET LIGHT

CHAPTER VIII

FEVER THERAPY CABINETS

SECTION 3

- ELECTRIC INDICATING THERMOMETER -

ELECTRIC INDICATING THERMOMETER

DIRECTIONS FOR OPERATION AND ADJUSTMENT OF ELECTRIC INDICATING THERMOMETER

READ THESE INSTRUCTIONS THROUGH COMPLETELY BEFORE PLACING INSTRUMENT IN SERVICE

The thermometer consists of the indicating instrument and the rectal applicator. The Electric Indicating Rectal Thermometer operates on the principle of the Wheatstone Bridge in which three of the resistance arms are of low temperature coefficient wire and the fourth arm, which is within the applicator bulb, is of high temperature coefficient wire. Current is supplied to the bridge from a battery of three flashlight cells connected in parallel for the purpose of giving them long life. The scale of the galvanometer is subdivided into divisions of 0.2 degree Fahrenheit and the position of the pointer may be further estimated to 1/4 division.

The thermometer case is furnished with soft rubber feet and can be placed on any cabinet or table suitable close to the patient.

SPECIAL NOTE -- READ CAREFULLY

USE OF ELECTRIC THERMOMETER WITH HIGH FREQUENCY FEVER MACHINE*

This Electric Indicating Thermometer can not be used in a high frequency field and therefore should not be used while the Fever Machine is in operation. The thermometer is to be used only during the sustaining period and cooling period after the Fever Machine current is off, and at any other time that the Fever Machine is not on.

The thermometer should be located at a distance far enough removed from the Fever Machine and the cables to the fever cabinet to prevent any possibility of the high frequency field affecting the instrument. A distance of five feet is sufficient. Care should be exercised that both the rectal applicator and the meter itself are at least this distance away from the field when the Fever Machine is in operation.

TESTS

There are two types of tests that should be made to insure the correct operation of this instrument, as follows:

A. Preliminary test, to make sure the instrument if functioning properly.
B. Calibration for accuracy of temperature indication.

A. PRELIMINARY TEST

This test should be made each time the instrument is used (before the treatment) and at intervals of not more than each hour or two during long fever bouts.

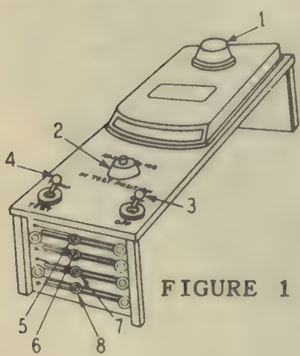


FIGURE 1

1. Place the "Temperature-Test" switch (No. 4 in Fig. 1) in the "Test" position, and the "On-Off" switch (No. 3 in Fig. 1) in the "Off" position. The pointer should indicate 96 degrees F. If the pointer does not indicate 96 degrees F., bring it to that value by rotating the knob located on the top of the meter movement case. (No. 1 in Fig. 1).

2. Turn the "On-Off" switch (No. 3) to the "On" position leaving the "Test-Temperature" switch (No. 4) in the "Test" position. The pointer should indicate 108 degrees F. If the pointer goes beyond or does not reach this point, the knob located directly in front of the temperature indicating dial (No. 2 in Fig. 1) should be rotated to bring the pointer to the 108 degree F. position. The thermometer is now ready for use.

B. CALIBRATION FOR ACCURACY

Although care is used in the manufacture, testing, handling and shipment of this thermometer, the user should not assume nor can the manufacturer guarantee its accuracy, because damage of one type or another after inspection or in transit may introduce an error that can be detected by comparing its reading with the reading of an *accurate* mercury thermometer. It is advisable also at frequent intervals to make check tests by placing the mercury thermometer carefully in the rectum alongside of the applicator.

In order to insure that the Electric Indicating Thermometer is in proper calibration when received and at any future time when there may be a question as to its accuracy, the following procedure should be followed in calibrating the instrument. For this test two constant temperature baths and an accurate mercury thermometer are necessary.

* High Frequency Machine hereafter referred to as Fever Machine.

The most satisfactory water bath consists of a one-pint size genuine thermos bottle, about ¾ filled with water. Genuine thermos bottles are double walled glass containers silvered on both the interior surfaces of the inner container and highly evacuated between the inner and outer chamber. This glass container is built into a cylindrical metallic insulated case. This construction insures a maximum of insulation and, therefore, a minimum of temperature loss.

A high grade capillary thermometer, the accuracy of which is unquestioned and which is calibrated at total immersion in divisions not closer than $1/10^{\circ}$ F., and preferably in divisions of five hundredths of a degree Fahrenheit, must be obtained and used for calibration. It is unlikely that the average hospital will have a thermometer of this sort but they are available usually from chemical or physical testing laboratories or laboratories of colleges and in some cases laboratories of well equipped high schools. Loan or rental of these thermometers usually can be arranged without difficulty.

The capillary thermometer probably will not indicate exactly the temperature of the bath for the following reasons: Practically all high grade capillary thermometers are calibrated by total immersion in a fluid. Usually when in use the thermometers are only partially immersed in a fluid while the remainder of the stem projects into the room and is therefore surrounded by air and is at air temperature, which in most cases is several degrees lower (and in some cases higher) than the temperature to which the mercury bulb is exposed. (This effect will be greater when the instrument is checked at the 108 degree F. point.) Because of this discrepancy it is necessary to correct the indicated reading of the capillary thermometer by a procedure known as stem correction.

Stem correction is necessary because of unequal rate of expansion of glass and mercury which increases both the bore and length of that portion of the thermometer immersed in a liquid warmer than the medium which surrounds the projection section of the stem. The following formula should be used to obtain the necessary correction.

.00009 N (T - t) where N is the total number of Fahrenheit degrees of calibration on the thermometer between the level of the fluid in which the bulb is immersed and the top of the indicating mercury column.

"T" is the indicated temperature in degrees Fahrenheit of the bath.

"t" is the room temperature in degrees Fahrenheit.

Room temperature may be taken with another mercury thermometer; an ordinary room temperature is satisfactory. This thermometer should be fairly close to the thermos bottle or to the stem of the immersed thermometer. This stem correction factor may be easily understood by reference to the following example: Let us assume that when a reading is taken the mercury thermometer reads 96.0° F. Let us further assume that the room temperature is 72° and that the mercury thermometer was immersed in the water bath to the graduation line of 55° F.

Then .00009 (96.0 - 55) (96.0 - 72)
(.00009) (41) (24)
.00009 x 41 x 24 is equal to $.890^{\circ}$ which must be *added* to the indicated reading of the capillary thermometer to obtain the actual temperature of the water bath. (If the room temperature is higher than 96°, then the third factor (T-t) is negative and it should be subtracted.) This correction when added to 96 gives 96.09 as the actual water temperature. Since the electric thermometer indicated 96.14 when the

mercury thermometer read 96, the form reads .05^{o} high, which is within the range of accuracy of a plus or minus 0.1^{o} tolerance permitted on this instrument.

The tip of the capillary thermometer and that of the applicator should be fastened together by means of a rubber band. The two then should be immersed in the constant temperature water bath. The immersion should be only to, or slightly beyond, the beginning of the enlarged portion of the applicator nearest the cord. At no time should the applicator be immersed far enough so that the liquid may splash over the top. The thermometer and applicator tip may be suspended in the water and away from the walls by wrapping a piece of wire around the two, and fastening the two ends of the wire around the neck of the thermos bottle. Gauze or crepe paper should be stuffed lightly around the mouth of the bottle to improve the insulation. With this set-up the temperature change of the bath will be approximately 1^{o} per hour, and to all practical purposes may be considered a constant temperature bath.

Water at approximately 100^{o} F. should be placed in the thermos bottle and the applicator tip and thermometer should be immersed in the water as described above. An interval of at least 15 minutes must elapse before any measurements are made to allow the thermometers and water to come to equilibrium. The temperature of the bath should be exactly 96^{o} F. as indicated by the capillary thermometer including stem correction before calibration of the 96^{o} point is made.

With the "On-Off" switch (No. 3) in the "Off" position, the zero adjustment knob (No. 1) located on the top of the meter movement should be adjusted to bring the pointer to the 96^{o} F. position. The "On-Off" switch (No. 3) should now be placed in the "On" position and the "Test-Temperature" switch (No. 4) in the "Test" position. The adjustment knob (No. 2) should be rotated until the pointer indicates 108. The "Test-Temperature" switch (No. 4) should be turned now to the "Temperature" position. After an interval of two or three minutes, the meter will be ready to be closed. Readings of the two thermometers may be taken consecutively as close together as possible. and should be recorded for future reference if desirable.

If the reading of the electric thermometer does not agree with that of the mercury thermometer after the stem correction has been made then the movement should be removed from the case (as explained in the section "Battery Replacement" which appears later in these instructions) after which four small sliders (Nos. 5, 6, 7 and 8 in illustration) will be visible mounted below and at the end of the movement panel nearest the two switches. Switch (3) should now be turned to the "Off" position and if the pointer does not settle at 96, it should be brought to that point by turning knob (1), after which switch (3) should be turned to the "On" position and switch (4) to "Temp" position. When the actual temperature of the bath is 96^{o} F. the screw on either or both of the two top sliders (Nos. 5 and 6) should be loosened and the sliders should be moved and tightened in the position required for the pointer to indicate 96^{o} F.

If this part of the calibration point was correctly made when the actual temperature of the bath is 96^{o} F. and pointer indicates 96^{o}, then rotating knob (2) should not affect the reading of the pointer.

In the thermos bottle now place water having a temperature of approximately 110 degrees. The test thermometer and the rectal applicator should be placed in this container as outlined above, and when the temperature of the water falls to 108 degrees F. as indicated by the mercury thermometer, after the stem correction has been made, rotate the adjustment knob (No. 2) immediately in front of the meter scale to bring the pointer to 108 degrees F. The "Test-Temperature" switch (No. 4) should now be placed in the "Test" position. If the pointer still settles at 108

degrees F.; no further adjustment is necessary. If it does not, adjustment of either or both of the two lower slides (Nos. 7 and 8) on the wires below and at the end of the panel should be made until the pointer reads 108 degrees F. The instrument should then be reassembled. It is now completely adjusted and ready for use.

The check of the electric thermometer in relation to the mercury thermometer may be repeated at any desired temperature value within the range of the electric thermometer by following the outline above but tests at one or two positions within the usual fever treatment range in addition to the checks at 96° and 108° should be sufficient to indicate the accuracy of the electric thermometer.

If a reading lower than that used for an initial test is desired it is advisable to allow the water bath to cool by normal radiation and conduction rather than by forcing cooling by the addition of cool water. This will probably require a period of hours but is more certain to give correct results.

Occasionally a centigrade thermometer may be available for test purposes when a Fahrenheit thermometer cannot be obtained. A centigrade thermometer is entirely usable if the following procedure is followed:

After the capillary thermometer indicated temperature has been read it should be converted to a Fahrenheit value as follows: Degrees Fahrenheit is equal to the centigrade reading times 9 divided by 5 and this result added to 32. The values "N", "T" and "t" in the stem correction formula must be converted also to Fahrenheit value by use of the above formula in order to make the stem correction.

MEASUREMENT OF PATIENT TEMPERATURE - The rectal applicator should be inserted to the second enlarged section at the upper end of the applicator. The "Test-Temperature" switch (No. 4) should be turned to "Temperature" position. After the applicator has been retained by the patient for two or three minutes, the thermometer will indicate the correct rectal temperature. The exact time which a rectal applicator must remain in the patient before a temperature reading is made can be determined by watching the meter needle and when it has arrived at a stable point, the reading should be made.

STERILIZING THE RECTAL APPLICATOR - The applicator should not be completely immersed in any liquid. There is danger that the liquid may seep past the cord and into the thermo sensitive coil, necessitating an expensive repair. THE APPLICATOR AND A PORTION OF THE CORD MAY BE WIPED WITH AN ALCOHOL SPONGE. AT NO TIME SHOULD THE APPLICATOR BE PLACED IN A STEAM STERILIZER OR TREATED WITH ANY STERILIZING AGENT WHICH WILL HAVE A DAMAGING EFFECT UPON RUBBER.

WHEN NOT IN USE - When the instrument is not in use, the "On-Off" switch (No. 3) should be turned to the "Off" position to prevent drain on the batteries.

BATTERY REPLACEMENT - The drain on the battery is 3 milliamperes, which drain is divided between three flashlight cells wired in parallel in the battery case. This battery should provide many months of ordinary use. When it is no longer possible to bring the meter pointer to the 108 degree F. mark with the adjustment knob (No. 2) when the "On-Off" switch (No. 3) is in the "On" position and the "Temperature-Test" switch (No. 4) is in the "Test" position, it is necessary to replace the battery. This is accomplished by the removal of the four screws from the under side of the wooden case, permitting removal of the bakelite panel and instrument from the case. DO NOT REMOVE THE FOUR CORNER SCREWS IN THE BAKELITE TOP PANEL OF THE INSTRUMENT. Removal of the four screws from the bottom of the battery case permits removal of the panel and the meter assembly, and will

permit ready removal of the old battery. When replacing the battery with a new one, care should be taken to connect the positive of the battery to the positive clip.

The battery used in this instrument is known as Burgess Battery No. 3D.

After battery replacement, the preliminary test described in these instructions should be repeated.

PRECAUTIONS

1. Repeat Preliminary Test periodically.

2. Utmost care should be exercised to avoid excessive bending, twisting, or kinking of the cord. Otherwise, the life of the applicator and cord will be matereally lessened. Do not close sliding doors on cable. When necessary to run cable through a cabinet wall, drill a hole through the wall, plug the hole with a rubber cork having a suitable hole in it, cut cork in half to fit around cable, and draw cable through cork.

3. "No deflection" of the pointer on temperature or test position or a violent deflection toward either end of the scale indicates a broken cable.

4. The presence of fecal material on or around the applicator will cause thermal lag or low readings. An s.s. enema administered the night before treatment should aid in eliminating this source of error.

5. The sensitive applicator should never be completely immersed in any liquid as there is danger that liquid might seep past the cord and into the thermo-sensitive coil in spite of manufacturing precautions to exclude moisture. The applicator is filled with wax to aid in keeping out moisture. The temperature of the wax (and applicator) should never exceed 120 degrees F.

6. Moisture in the applicator tends to make the instrument read low and may make the readings erratic. See the paragraph on sterilizing the applicator for detailed information on how to keep the applicator clean.

7. The applicator must not be exposed to the high frequency field. High frequency current will heat the active element of the bulb to a temperature which will render it unreliable and will necessitate an expensive repair. Also, it could cause a serious burn.

8. If at any time the pointer fails to swing freely or the instrument does not appear to register temperatures correctly, it should be immediately set aside and examined carefully at leisure. If it does not properly respond to the calibration instructions given, it should be returned for repair to the proper depot.

CHAPTER IX
TYPEWRITERS

SECTION 1
- REMINGTON -

REMINGTON MODEL 17

REMOVING AND REPLACING OF TYPEWRITER UNIT - To remove top cover 2-41090 from the machine set the carriage to the left until the line space lever is not over the top cover. Place forefingers of both hands at point "A" at rear edges of top cover both sides and pull up gently until the rear of the cover has been released by the top cover detents 2-41091 right and 2-41092 left. Then guide top cover forward slowly until it is clear of the machine. The front of top cover is held into place by the dowel pins at front of the ribbon spool shaft bracket right 2-42349 and left 2-42350.

To remove the rear panel 2-41089 place fingers at top of panel and pull toward the rear until rear cover latches 2-41098 right and 2-41099 left release from their rear cover anchor screws 2-40215 and slide panel downward slightly to remove.

Remove the margin stop rack pull link eccentric screw 2-42714 and nut 2-40409. Remove both the right and left top cover aprons 2-41093 and 2-41094. Take out Platen roll 2-43646. Depress shift lock key. Make certain that the ribbon drive shaft arm assembled 2-46519 is pointing down toward the rear of the machine. See illustration.

Pull forward on both right and left unit latch locks 2-41084 (see illustration) and 2-41085 at the same time raise the front end of keyboard upward, causing the ribbon universal bar 2-42281 (Ribbon Cover Illustration) to clear space bar line lock pawls 2-41128. (Space Bar Illustration)

NOTE: The typewriter unit is not numbered, therefore, when it is removed from the base the serial number of machine should be scratched on the right side plate. This will prevent placing the units in the wrong bases.

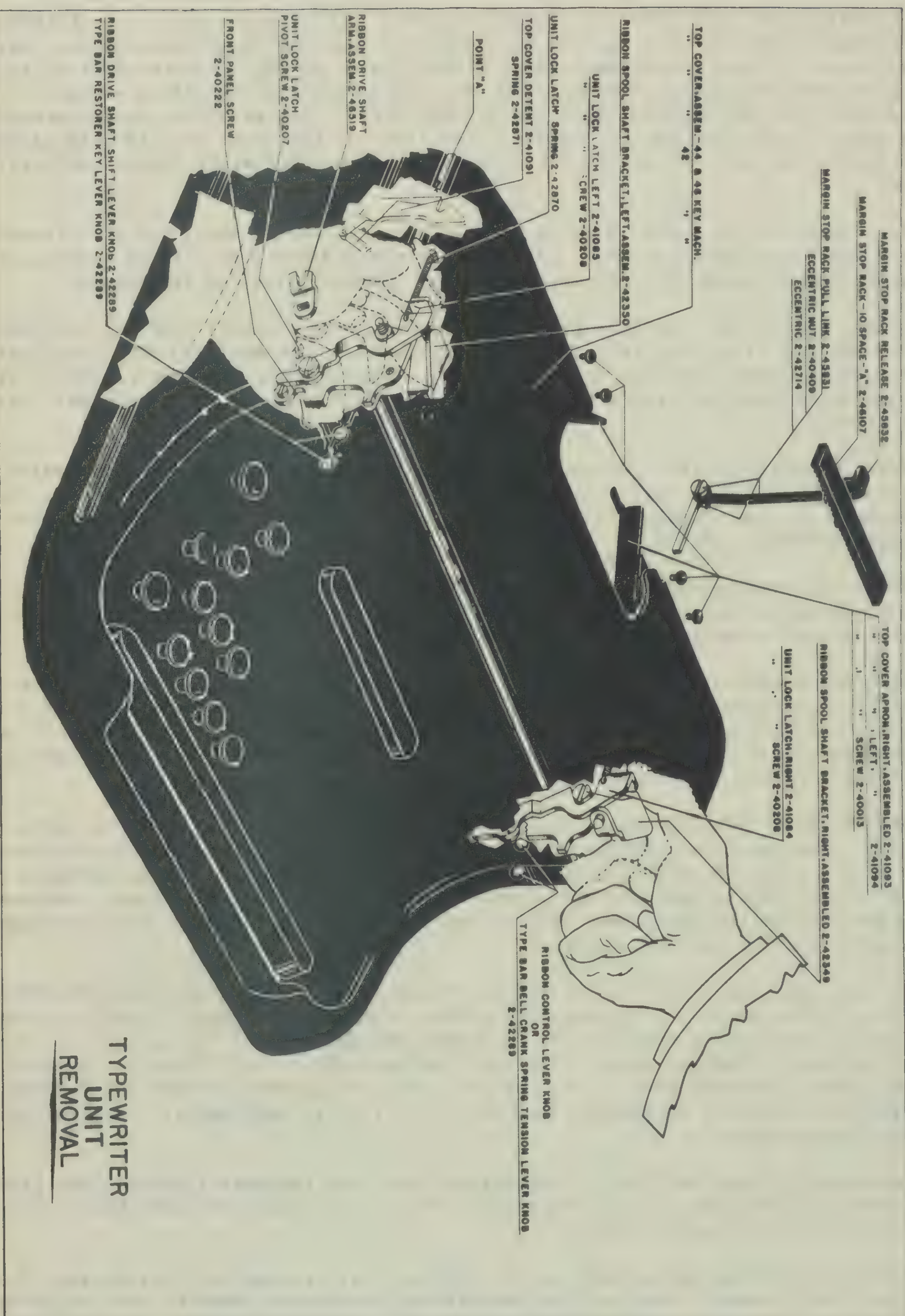
When the typewriter unit is out of the typewriter frame do not set it upright on work bench because of the parts extending below the typewriter unit side plates. A small board with a cleat on each end can be made to set the typewriter unit on while working on it outside of the typewriter frame. This will also permit operation of shift keys, key levers, etc.

REPLACING TYPEWRITER UNIT - Guide the typewriter unit back into the machine carefully, make sure that the fork of the ribbon drive shaft arm 2-46519 sets over its stud of ribbon driving gear 2-46516. (See Ribbon Drive Mechanism Sketches.) Have shift keys locked down and when unit is in typewriter base far enough pressure may be exerted on the key lever comb at top right and left ends. This pressure should be toward the rear and downward.

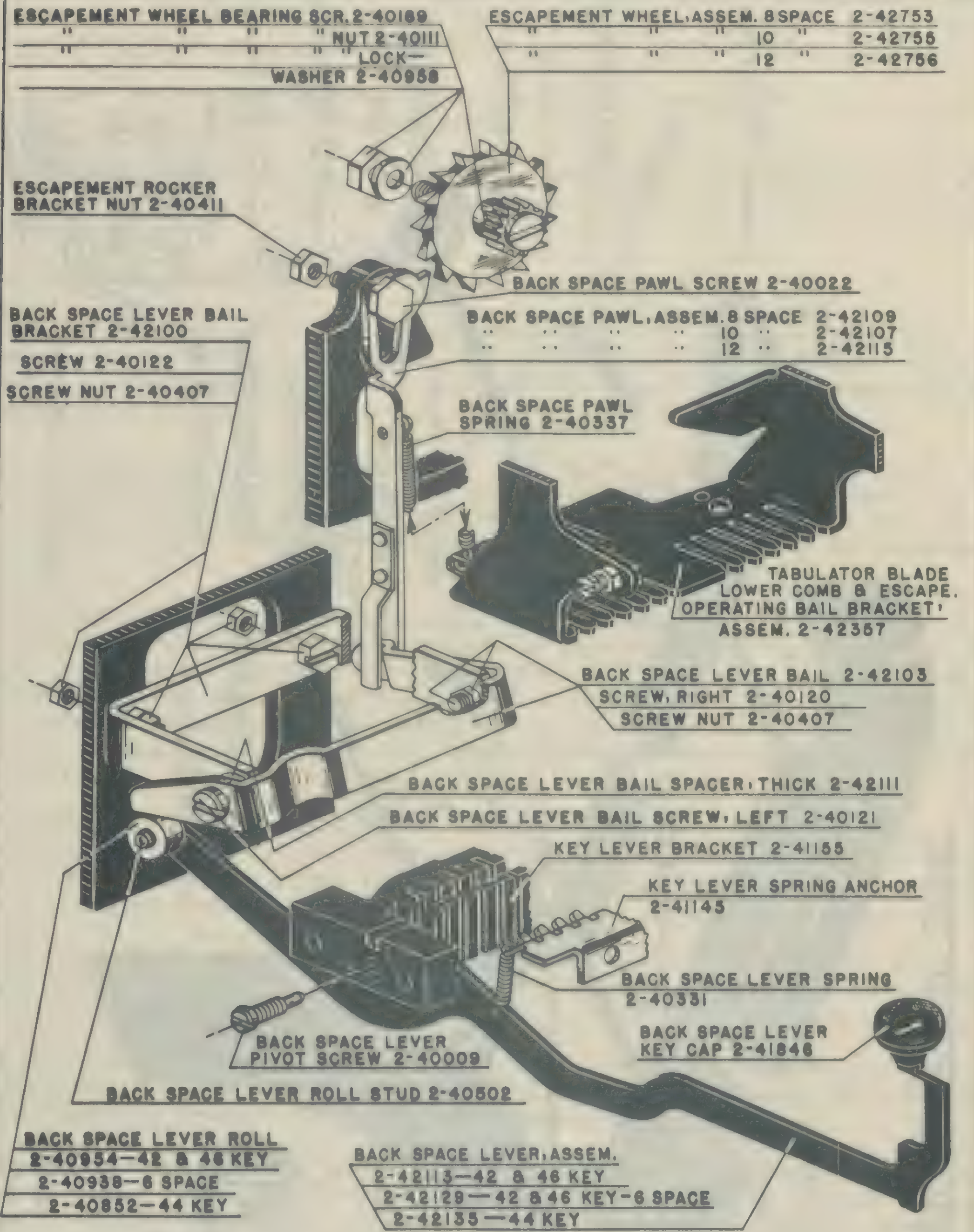
If unit does not slide into position, check the tabulator bell crank 2-42413 (tabulator illustration), they may not be down in normal position. Check the side plates of the typewriter unit and see that they are setting all the way down on the typewriter frame. Replace margin stop pull link eccentric 2-42714 and nut 2-40409. Replace platen. Replace both right and left top cover aprons 2-41093 and 2-41094, test line lock and bell mechanism, tabulator, shift keys, back space, space bar and keyboard for operation.

Occasionally when setting the typewriter unit into the base the space bar line link pawls 2-41128 (space bar illustration) may go up between the wrong key levers, which will cause key levers to bind.

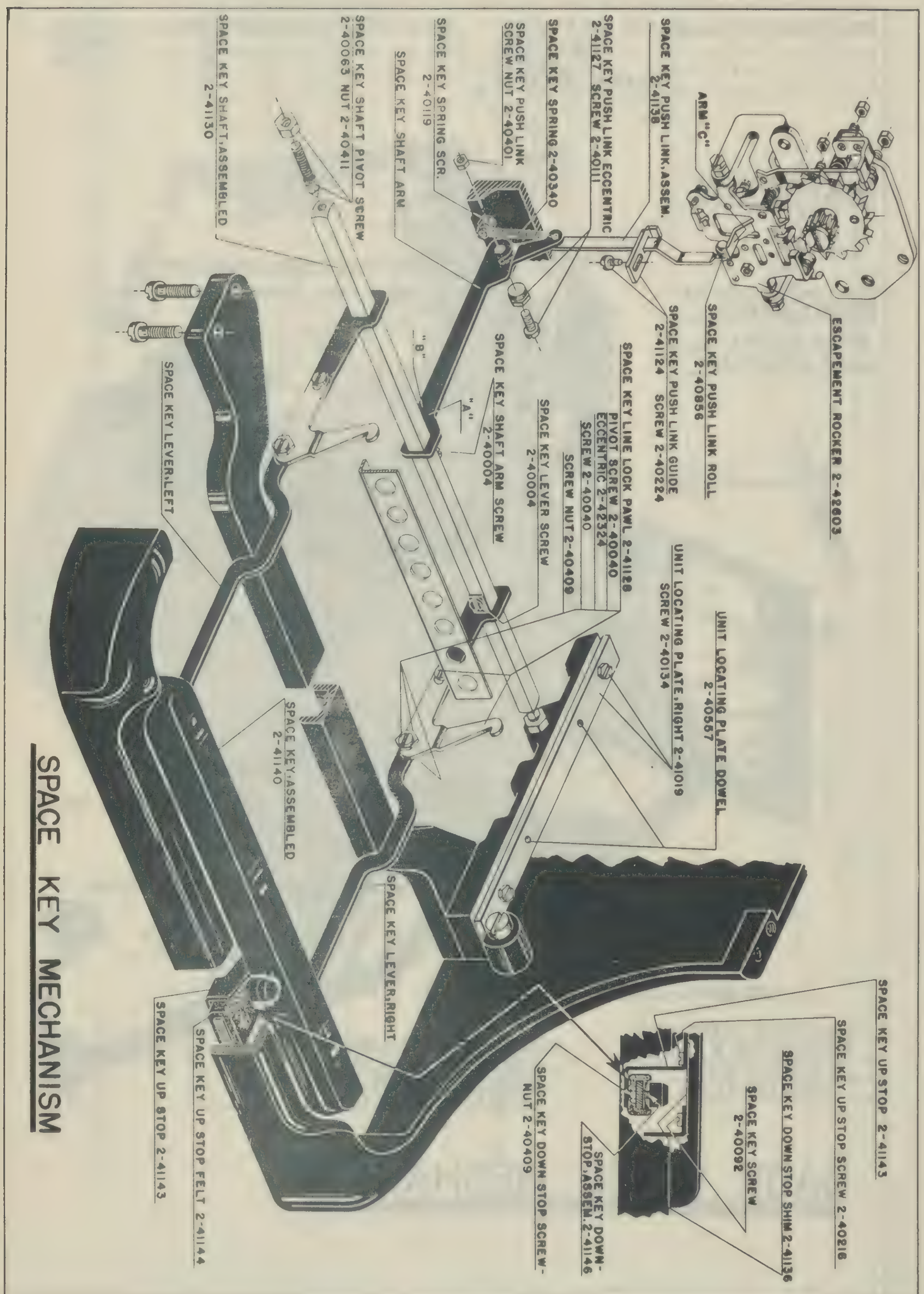
There are certain adjustments in the machine that are more accessible with the typewriter unit removed, however, the majority of them can be made by only removing the panels.



TYPEWRITER UNIT REMOVAL



BACK SPACE MECHANISM



SPACE KEY MECHANISM

Replace rear panel 2-41089 and top cover 2-41090, after replacing top cover always test the ribbon spool shafts for free. If carriage is sluggish after replacing rear panel, note whether rear panel is pressing against rear carriage rail.

CAUTION: Do not set typewriter on its back without using a felt pad to prevent marring the finish of the rear panel 2-41089.

BACK SPACE MECHANISM - This mechanism is very simple in construction and will require very little adjusting. It is necessary as in all parts of the machine to have free moving parts.

If the back space fails to operate check the following:

See that the back space pawl spring 2-40337 has sufficient tension to hold the back space pawl 2-42107 clear of the escapement wheel teeth. Also see that the pawl is free in movement and that the back space key lever roll is in alignment with the back space lever bail 2-42103 as illustrated.

The escapement rocker body should be located so that the loose dog holds the escapement wheel in such a position that the tooth of the escapement wheel will be fully engaged by the back space pawl when back space is operated. The location of the escapement rocker body has been described in the text covering the escapement mechanism.

SPACE KEY MECHANISM - The space key shaft is supported in the machine by the back space key shaft pivot screws 2-40063 and when the space bar 2-41140 is depressed, it causes the space key shaft arm, to which the space key push link 2-41138 is attached, to move upward. The space key push link roll 2-40856 contacts arm "C" on the escapement rocker body, causing the escapement to take place. When the escapement is complete, the space key spring 2-40240 returns the key to its normal rest position.

ADJUSTMENTS - First, the space key shaft 2-41130 should be centrally located, free but without end play between pivot screws 2-40063. If there is end play , remove by adjusting pivot screws 2-40063 making sure that the lock nuts 2-40411 are securely tightened after making this adjustment.

The height of the space bar 2-41140 is correct when the bottom of the space bar is level with the top of the machine frame front (center). This adjustment is made by forming the space key upstop 2-41143. Refer to illustration sub-view.

With the space bar 2-41140 depressed, the top of the space bar should be flush with top corner of machine frame (front). This adjustment is made by adjusting the space key downstop screws 2-41146. Refer to illustration sub-view.

The space key push link guide 2-41124 screw hole is elongated to facilitate adjusting the push link to its proper position. It is preferable to have the push link roll 2-40856 located near the front end of arm "C". This position makes the space key operation easier. Unhook the space key spring 2-40340 and test space key mechanism for freedom of movement. The space key push link 2-41138 must be free in its guide 2-41124. When testing the space key mechanism for freedom of movement hold forward on the lower part of the escapement rocker body, noting carefully if any binding exists. If the mechanism seems to be sluggish or binding, check again for freedom as already explained. After this has been done be sure to hook up the space key spring 2-40340.

Adjust the push link eccentric 2-41127 until the escapement takes place when the space bar is within 1/16" of the space key downstop screws 2-41146. If the eccentric does not give enough movement to the push link to get this condition it will be necessary to maul or pein the space key shaft arm at point "A" to lower it, or at point "B" to raise it.

Check the space key line lock pawl pivot screws 2-40040 and nuts 2-40409 to see that they are tight. If these are loose it permits the space key line lock pawls to vibrate, causing a noisy space key operation.

When the space key is depressed against downstop screws 2-41146, the escapement rocker body 2-42603 must not limit against upper rocker body stop screw 2-40100 shown on escapement illustration (rear view).

RIBBON DRIVE MECHANISM - The drawings covering this mechanism show in detail the assembly of the parts which govern the ribbon drive and reverse. The movement of the parts originate at the carriage spring drum which through the spring drum pinion 2-46509, spring drum pinion shaft 2-46507 and ribbon drive gear 2-46516 drives the ribbon drive shaft arm 2-46519.

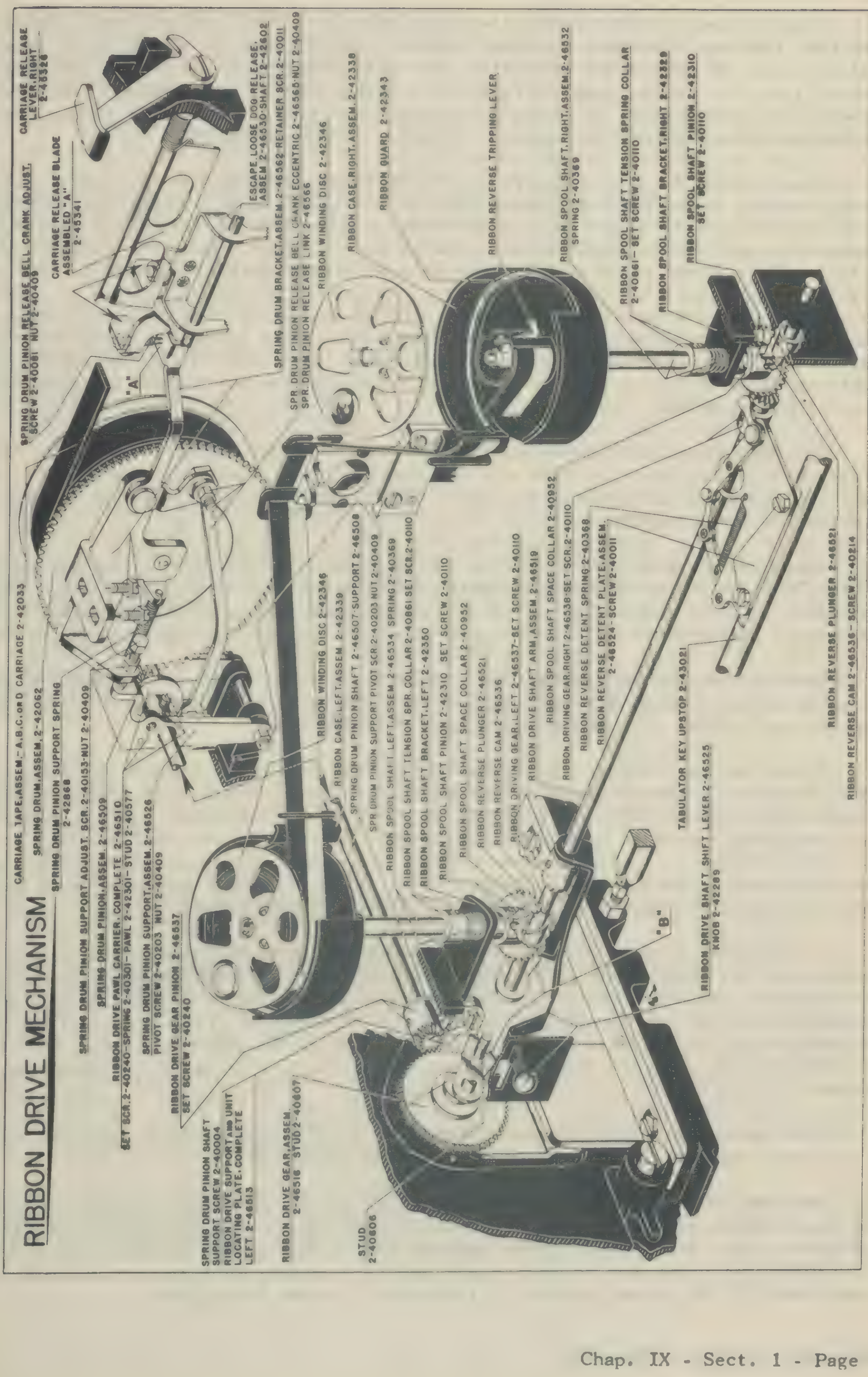
On the ribbon drive shaft arm 2-46519 are mounted the ribbon reverse cam left 2-46536 and ribbon reverse cam right 2-46536. The reverse cam left 2-46536 is set between the arms of ribbon drive shaft lever 2-46525 as shown on the drawing. The ribbon reverse detent plate 2-46524 controls the right and left positions of the ribbon drive shaft arm 2-46519. When the ribbon driving gear 2-46538 (right) is in mesh with the right ribbon spool shaft pinion 2-42310 the ribbon will wind on to the right spool until the left spool is empty. At this point the ribbon reverse tripping lever raises and allows the left ribbon reverse plugger 2-46521 to engage the ribbon reverse cam left 2-46536. This causes the ribbon drive shaft arm 2-46519 to be shifted to the left which reverses the travel of the ribbon onto the left, or empty spool.

ADJUSTMENTS - We will assume for explanation that the assembly of the ribbon mechanism has been made according to sketch but not adjusted.

It is first necessary to adjust the up and down play and the tension of the ribbon spool shafts right 2-46532 and left 2-46534. There is one shaft tension spring collar 2-30861 on each shaft. Loosen the set screws 2-40110 in both ribbon spool shaft tension spring collars 2-40861, also loosen set screws 2-40110 in both right and left ribbon spool shaft pinions 2-42310. Place .008 thickness gage between top of ribbon spool shaft space collar 2-40952 and bottom of ribbon spool shaft bracket (right) 2-42329. Hold down on top of ribbon spool shaft right 2-46532 and at the same time hold upward on the ribbon spool shaft pinion 2-42310 and tighten its set screw 2-40110. Remove .008 thickness gage and check ribbon spool shaft 2-46532 for play and also free to spin. Repeat this operation and adjust left ribbon spool shaft 2-46534.

Ribbon spool shafts right and left are not interchangeable. When ribbon reverse trip lever is facing you and narrow slot for ribbon is on left side it is the right ribbon spool shaft 2-46532, if the narrow slot for ribbon is on the right side of ribbon reverse trip lever it is the left ribbon spool shaft 2-46534.

The tension of the ribbon spool shafts right 2-46532 and left 2-46534 should be just enough to support the weight of a full spool of ribbon and ribbon winding disc 2-42346 without any drop or sag in shafts. This is adjusted by the ribbon spool shaft tension spring collars 2-40861 which when positioned on the shaft will compress or release the tension of the ribbon spool shaft spring 2-40369. After adjustments are made tighten set screws 2-40110 in collars 2-40861 and see that the ribbon reverse plungers right and left and their tripping levers are free in their movement.


RIBBON DRIVE MECHANISM
CARRIAGE TAPE, ASSEM.- A.B.C. or D CARRIAGE 2-42033
SPRING DRUM, ASSEM. 2-42062
SPRING DRUM PINION SUPPORT SPRING 2-42868
SPRING DRUM PINION SUPPORT ADJUST. SCR. 2-40153-NUT 2-40409
SPRING DRUM PINION, ASSEM. 2-46509
RIBBON DRIVE PAWL CARRIER, COMPLETE 2-46510
SET SCR. 2-40240-SPRING 2-40301-PAWL 2-42301-STUD 2-40577
SPRING DRUM PINION SUPPORT, ASSEM. 2-46526
PIVOT SCREW 2-40203 NUT 2-40409
RIBBON DRIVE GEAR PINION 2-46537
SET SCREW 2-40240
SPRING DRUM PINION SHAFT SUPPORT SCREW 2-40004
RIBBON DRIVE SUPPORT AND UNIT LOCATING PLATE, COMPLETE LEFT 2-46513
RIBBON DRIVE GEAR, ASSEM. 2-46516 STUD 2-40807
STUD 2-40806
SPRING DRUM PINION RELEASE BELL CRANK ADJUST. SCREW 2-40081 NUT 2-40409
CARRIAGE RELEASE BLADE ASSEMBLED "A" 2-45341
CARRIAGE RELEASE LEVER, RIGHT 2-45326
ESCAPE. LOOSE DOG RELEASE, ASSEM 2-46530-SHAFT 2-42602
SPRING DRUM BRACKET, ASSEM. 2-46562-RETAINER SCR. 2-40011
SPR. DRUM PINION RELEASE BELL CRANK ECCENTRIC 2-46565-NUT 2-40409
SPR. DRUM PINION RELEASE LINK 2-46566
RIBBON WINDING DISC 2-42346
RIBBON CASE, RIGHT, ASSEM. 2-42338
RIBBON GUARD 2-42343
RIBBON REVERSE TRIPPING LEVER
RIBBON SPOOL SHAFT, RIGHT, ASSEM. 2-46532 SPRING 2-40369
RIBBON SPOOL SHAFT TENSION SPRING COLLAR 2-40861- SET SCREW 2-40110
RIBBON SPOOL SHAFT BRACKET, RIGHT 2-42329
RIBBON SPOOL SHAFT PINION 2-42310 SET SCREW 2-40110
RIBBON WINDING DISC 2-42346
RIBBON CASE, LEFT, ASSEM 2-42339
SPRING DRUM PINION SHAFT 2-46507-SUPPORT 2-46508
SPR DRUM PINION SUPPORT PIVOT SCR 2-40203 NUT 2-40409
RIBBON SPOOL SHAFT LEFT, ASSEM 2-46534 SPRING 2-40369
RIBBON SPOOL SHAFT TENSION SPR. COLLAR 2-40861 SET SCR. 2-40110
RIBBON SPOOL SHAFT BRACKET, LEFT 2-42330
RIBBON SPOOL SHAFT PINION 2-42310 SET SCREW 2-40110
RIBBON SPOOL SHAFT SPACE COLLAR 2-40952
RIBBON REVERSE PLUNGER 2-46521
RIBBON REVERSE CAM 2-46536
RIBBON DRIVING GEAR, LEFT 2-46537-SET SCREW 2-40110
RIBBON DRIVE SHAFT ARM, ASSEM. 2-46519
RIBBON SPOOL SHAFT SPACE COLLAR 2-40952
RIBBON DRIVING GEAR, RIGHT 2-46538-SET SCR. 2-40110
RIBBON REVERSE DETENT SPRING 2-40368
RIBBON REVERSE DETENT PLATE, ASSEM. 2-46524-SCREW 2-40011
TABULATOR KEY UPSTOP 2-43021
RIBBON DRIVE SHAFT SHIFT LEVER 2-46525 KNOB 2-42289
RIBBON REVERSE PLUNGER 2-46521
RIBBON REVERSE CAM 2-46536-SCREW 2-40214
"A"
"B"

Check screws 2-40214 in both the right and left ribbon reverse cams 2-46536 and see that they are tight and also make certain that the cam surface of these cams are set opposite to each other on shaft. The reason for this is in case an operator should take the ribbon completely off the machine which would permit both ribbon reverse plungers 2-46521 to engage both cams which would lock up the ribbon driving mechanism if used unless set opposite as shown in the illustration.

Next adjust the ribbon reverse detent 2-46524. Loosen the two ribbon reverse detent screws 2-40011 and set screw 2-40110 in right ribbon driving gear 2-46538. Have detent set with toggle to rear as shown in illustration, also have detent stud engaged in slot of the right ribbon driving gear 2-46538. Move the ribbon reverse detent on its shaft until ribbon driving gear right 2-46538 meshes correct with right ribbon spool shaft pinion 2-42310. The gears should be meshed deep enough to insure positive feed and yet have a slight amount of play between the pinion and drive gear at all positions around the pinionl When correct position of detent has been determined, tighten the set screws 2-40011. Next slide the ribbon drive shaft arm 2-46519 to the extreme right and tighten set screw 2-40110 in right ribbon driving gear 2-46538.

Set the ribbon reverse detent 2-46524 to the front and lift up on the ribbon drive shaft shift lever 2-46525 and position the left ribbon driving gear 2-46537 until its gear is correctly meshed with the ribbon spool shaft pinion 2-42310 and tighten set screw 2-40110.

Remove the typewriter unit from the machine frame and check the spring drum pinion 2-46509. It must be meshed with the carriage spring drum gear deep enough to insure positive drive and yet have a slight amount of play at all points. This adjustment is obtained by the spring drum pinion support adjusting screw 2-40153.

Next loosen the two spring drum pinion shaft support screws 2-40004 and position the spring drum pinion shaft support 2-46508 for proper mesh up of ribbon drive gear pinion 2-46537 with ribbon drive gear 2-46516.

Adjust spring drum pinion release bell crank eccentric 2-46565 until there is .003 clearance between bottom of spring drum pinion release bell crank adjusting screw 2-40081 (Point "A") and top side of lip which it operates. If the condition just described cannot be obtained by adjusting eccentric it will be necessary to remove the carriage and adjust screw 2-40081 up or down until eccentric will handle the adjustment. However the eccentric is in the machine for convenience of making this adjustment without having to remove the carriage each time.

If the above adjustments have been made carefully as outlined, when an operator releases either right or left carriage release levers to move carriage to the left or tabulator key is operated the spring drum pinion support 2/46526 with gears should swing clear of the spring drum gear so that ribbon will not travel on these two operations, if ribbon did travel it would take up the slack in same. This slack is necessary for accurate ribbon covering particularly when using the lower half of ribbon.

Make sure when replacing the typewriter unit in the machine that arm "B" is placed over its stud 2-40606 of the ribbon drive gear 2-46516.

CAUTION: Do not force the unit into position until this is checked, otherwise the stud 2-40606 may be loosened or knocked out. Shift the ribbon drive shaft arm 2-46519 to right and left positions and see that it has a good hold on stud 2-40606. Try ribbon for reversing on both right and left spools near end of writing line. There should be no uneven spacing of letters as reverse takes place.

RIBBON COVER MECHANISM - In describing the movement of this mechanism, we will assume that all parts are free and that the adjustments are correct. The ribbon universal bar 2-42281 is supported by the ribbon universal bar pivot screws 2-40164 in the base of the machine, under the key levers.

When the key lever is depressed, the ribbon universal bar moves downward and as the universal bar is on a pivot, the arm "A" moves upward, causing the toggle link to move the front lower part of the toggle bell crank "B" upward. This upward movement is transferred to the ribbon actuator arm 2-46569 by the ribbon lift push link 2-42284. The ribbon lift push link stud 2-40571 fits into the slot of the ribbon actuator arm 2-46569 (the lower end of ribbon lift push link 2-42282 is attached to the lower front extension of the toggle bell crank "B" as illustrated).

When the ribbon control lever 2-46568 is in its upward position it will cause the ribbon lift push link stud 2-40571 to be in the front end of the slot "C" in ribbon actuator arm 2-46569; this causes the type to print on the upper half of ribbon. When the ribbon control lever is set to its lower position, it causes the ribbon control shaft lever 2-42285 to move the upper end of the ribbon lift push link 2-42284 to the rear, positioning ribbon lift push link stud 2-40571 to rear end of slot "C". This causes the type to print on the lower half of the ribbon.

When the ribbon control lever 2-46568 is set at white dot or stencil position, the control shaft will hold the ribbon lift push link in a central position, so that the ribbon lift push link stud 2-40571 will move up and down in slot "C" without operating the ribbon carrier 2-46570. When ribbon universal bar and all parts related to the ribbon cover are in normal position, the ribbon actuator arm 2-46569 limits on ribbon actuator arm stop pin 2-40500.

ADJUSTMENTS - We will assume that the machine has been adjusted for "on feet" and motion, and that the machine is equipped with a ½ inch black and red ribbon. (Machines with larger type are equipped with 9/16 inch ribbon carrier). The black or upper half of the ribbon is adjusted for cover first.

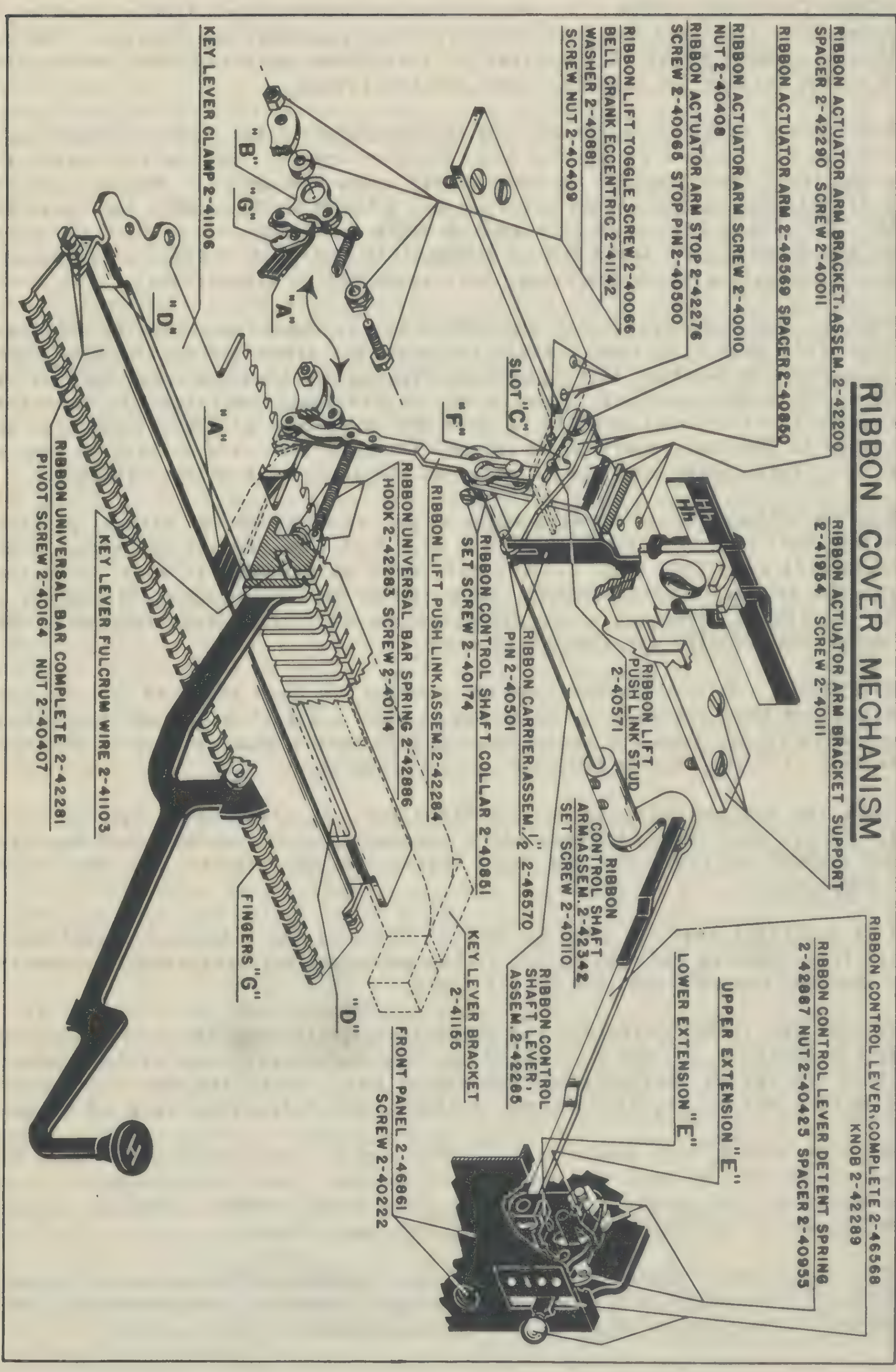
Check the ribbon universal bar 2-42281 for end play between pivot screws 2-40164. Excess play should be removed by loosening the ribbon universal bar pivot screw nut 2-40407 and tightening the pivot screws 2-40164. Tighten nut when adjustment is completed.

It is important that all play be removed and that the ribbon universal bar is perfectly free. Excess end play in the ribbon universal bar will result in the ribbon not throwing the same distance at all times.

See that the ribbon universal bar 2-42281 is level; this can be tested by depressing key levers z, n, and / -- all three type bars travel same distance about ½ inch before key levers contact ribbon universal bar. This lead can be changed by forming points "D" of key lever clamp 2-41106 toward front or back of machine.

Loosen the ribbon lift toggle screw 2-40066 and set the ribbon lift toggle bell crank eccentric 2-41142 with the big side to bottom. Lock the eccentric in this position with the lift toggle screw 2-40066 and its nut 2-40409. This is a temporary setting and it may be necessary to adjust it again later.

NOTE: There are certain adjustments pertaining to the ribbon covering mechanism that are more accessible with the typewriter unit removed from the base such as adjusting the rubbon control shaft by set screws 2-40110.


RIBBON COVER MECHANISM
RIBBON ACTUATOR ARM BRACKET, ASSEM. 2-42200
SPACER 2-42290 SCREW 2-40011
RIBBON ACTUATOR ARM 2-46569 SPACER 2-40850
RIBBON ACTUATOR ARM SCREW 2-40010
NUT 2-40408
RIBBON ACTUATOR ARM STOP 2-42276
SCREW 2-40066 STOP PIN 2-40500
RIBBON LIFT TOGGLE SCREW 2-40066
BELL CRANK ECCENTRIC 2-41142
WASHER 2-40881
SCREW NUT 2-40409
KEY LEVER CLAMP 2-41106
"B"
"G"
"A"
"D"
"A"
"F"
SLOT "C"
RIBBON ACTUATOR ARM BRACKET SUPPORT
2-41954 SCREW 2-40111
RIBBON LIFT PUSH LINK STUD 2-40571
RIBBON CARRIER, ASSEM. 1/2" 2-46570
PIN 2-40501
RIBBON CONTROL SHAFT COLLAR 2-40881
SET SCREW 2-40174
RIBBON LIFT PUSH LINK, ASSEM. 2-42284
RIBBON UNIVERSAL BAR SPRING 2-42886
HOOK 2-42283 SCREW 2-40114
KEY LEVER FULCRUM WIRE 2-41103
RIBBON UNIVERSAL BAR COMPLETE 2-42281
PIVOT SCREW 2-40164 NUT 2-40407
RIBBON CONTROL SHAFT ARM, ASSEM. 2-42342
SET SCREW 2-40110
RIBBON CONTROL SHAFT LEVER, ASSEM. 2-42265
KEY LEVER BRACKET 2-41155
FINGERS "G"
"D"
FRONT PANEL 2-46861
SCREW 2-40222
RIBBON CONTROL LEVER, COMPLETE 2-46568
KNOB 2-42289
RIBBON CONTROL LEVER DETENT SPRING
2-42887 NUT 2-40425 SPACER 2-40955
UPPER EXTENSION "E"
LOWER EXTENSION "E"

Set the ribbon control lever 2-46568 in its stencil position, which is white dot on front panel. Loosen the two ribbon control shaft arm set screws 2-40110 and move the arm "F". When a key lever is depressed, stud 2-40571 will go up directly into center of vertical slot at top of slot "C". The closer this adjustment is made the better other ribbon covering adjustments will come out. While holding arm "F" as described tighten the two ribbon control shaft arm set screws 2-40110.

Set ribbon control lever 2-46568 to top position which is blue dot. Form lower extension "E" making sure that stud in ribbon control lever 2-46568 sets securely in its position in ribbon control lever detent spring 2-42887. Depress the shift lock key and test the black cover by striking off a few capital "HHHHH". They should strike in the center of the black or upper half of ribbon. If the type strikes high on the ribbon, it will be necessary to turn the ribbon lift toggle bell crank eccentric 2-41142 toward the front; after adjusting the eccentric, lock its position with ribbon lift toggle screw 2-40066 and try the cover again with the capital "H". If the type is striking too low on the ribbon, reverse this procedure. Test black covering by typing the alphabet and numerals in both upper and lower cases. The black upstop "G" prevents the ribbon from overthrowing and printing bottom of characters red. No adjusting necessary on this upstop.

Set the ribbon control lever 2-46568 to red dot which is lower half or red ribbon position. Form upper extension "E" making sure that stud in ribbon control lever 2-46568 set securely in its position in ribbon control lever detent spring 2-42887. Strike off the alphabet and numerals of both upper and lower cases. Form the ribbon actuator arm stop 2-42276 until the ribbon actuator arm 2-46569 almost limits against it when the key lever is depressed. This stop prevents the ribbon from overthrowing and failing to print the bottom of red characters. If the ribbon carrier goes up and does not drop back down it is an indication that the ribbon actuator arm stop 2-42276 is formed too low.

When ribbon control lever 2-46568 is set at white dash (-) on front panel the face of type will strike in center of ribbon, therefore if a solid black ribbon is used the customer can get more wear from the ribbon than was possible with old style construction by using the center of ribbon. There is no adjustment on this. It will be correct if black and red portion of ribbon is covering correctly.

When shifting the ribbon control lever 2-46568 from black to red or vice versa, there should be no movement in the ribbon carrier 2-46570. If the ribbon carrier moves it indicates that the top of stud 2-40571 is rubbing the top of slot "C".

Check the following adjustments in regard to movement in the ribbon carrier 2-46570, when shifting the ribbon control lever: Ribbon universal bar 2-42281 limiting against under sides of key levers, which could be caused by improperly adjusted ribbon lift toggle bell crank eccentric 2-41142 or one of the individual fingers "G" on the ribbon universal bar may be formed higher than necessary or rear side of spring clip on ribbon lift push link 2-42284 interfering with toggle bell crank "B" when set on red. The fingers "G" on the universal bar provide an individual adjustment in case the ribbon carrier does not raise the proper height on a few characters.

The ribbon universal bar, ribbon carrier, ribbon lift push link, etc. are restored to their normal position by the ribbon universal bar spring 2-42886.

Hold the ribbon actuator arm bracket support 2-41954 to the rear when tightening support screws 2-40111. This will prevent the front end of ribbon actuator arm 2-46569 from binding on rear side of segment.

TYPE ACTION MECHANISM - Freedom of parts in the key lever and type bar connections is most important. When the key lever 2-41222 is depressed it fulcrums on the key lever fulcrum wire 2-41103. The type bar bell crank 2-41622 is made to travel toward front of machine by the type bar bell crank link being positioned over stud "A" on the key lever 2-41222. Since the upper end of the type bar bell crank 2-41622 is connected to the type bar 2-41783 by a type bar link 2-41432, it pivots the type bar 2-41783 on the type bar fulcrum wire 2-41594 and causes the type bar to travel in an arc which ends when the type strikes the platen roll.

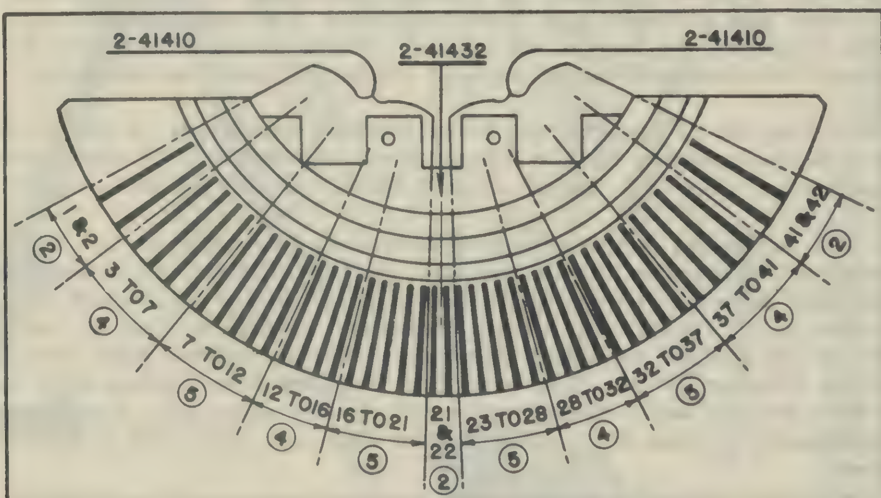
The tension of the following springs aid in the return of key lever and type bar connections to normal position:

Key lever spring 2-40331
Type bar bell crank spring 2-40338
Escapement rocker spring 2-40300 (Escapement illustration)
Type bar universal bar oscillator spring 2-42862 (Escapement illustration)

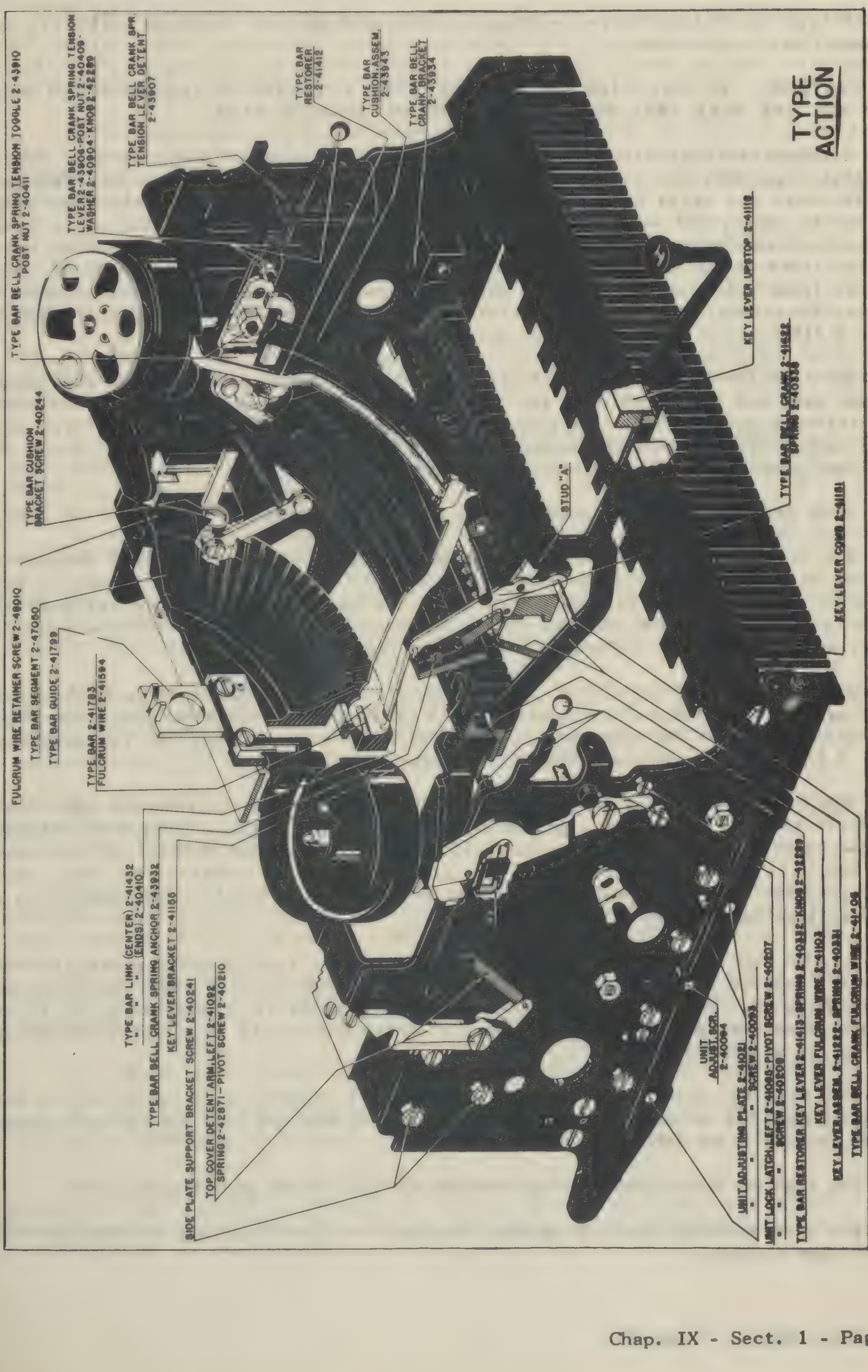
Test key levers to see that they move freely in the slots of key lever comb 2-41151. Check to see that the type bar bell crank link does not bind on stud "A" in the key lever 2-41222 and that the type bar link is of the proper form to prevent bind between the type bar bell crank 2-41622 and type bar 2-41783.

After key lever 2-41222 has been struck, the type bar 2-41783 should return to rest position at the type bar cushion 2-43943 without tension of the type bar universal bar or escapement rocker spring 2-40300. (Escapement illustration.) Try each type bar for freedom of movemdnt, if sluggish, examine points mentioned in the above paragraph, and examine the slots in type bar segment 2-47050 and type bar bell crank bracket 2-43934 to see that they are clean and free of foreign substance.

There are 10 different kinds of type bar links as shown on illustration below:



Since there are ten different kinds of type bar links, it will be necessary to replace them in their original position after removing type bars and segment for cleaning. One method is to drill forty-two holes in a small board, numbering the holes consecutively from one to forty-two and as the type bar link is removed from the number one type bar, place it in the number one hole of board, etc. The left


TYPE ACTION
TYPE BAR BELL CRANK SPRING TENSION TOGGLE 2-43910
POST NUT 2-40411
TYPE BAR BELL CRANK SPRING TENSION LEVER 2-43906-POST NUT 2-40409-WASHER 2-40904-KNOB 2-42289
TYPE BAR BELL CRANK SPR. TENSION LEVER DETENT 2-43907
TYPE BAR RESTORER 2-41412
TYPE BAR CUSHION ASSEM. 2-43943
TYPE BAR BELL CRANK BRACKET 2-43934
KEY LEVER UPSTOP 2-41118
TYPE BAR BELL CRANK 2-41682
SPRING 2-40318
KEY LEVER COMB 2-41151
STUD "A"
TYPE BAR CUSHION BRACKET SCREW 2-40244
FULCRUM WIRE RETAINER SCREW 2-48010
TYPE BAR SEGMENT 2-47050
TYPE BAR GUIDE 2-41799
TYPE BAR 2-41793
FULCRUM WIRE 2-41594
TYPE BAR LINK (CENTER) 2-41432
" " " (ENDS) 2-40410
TYPE BAR BELL CRANK SPRING ANCHOR 2-43932
KEY LEVER BRACKET 2-41155
SIDE PLATE SUPPORT BRACKET SCREW 2-40241
TOP COVER DETENT ARM, LEFT 2-41092
SPRING 2-42871—PIVOT SCREW 2-40210
UNIT ADJUST. SCR. 2-40094
UNIT ADJUSTING PLATE 2-41021
" " SCREW 2-40093
UNIT LOCK LATCH, LEFT 2-41085-PIVOT SCREW 2-40207
" " " SCREW 2-40208
TYPE BAR RESTORER KEY LEVER 2-41413-SPRING 2-40332-KNOB 2-42289
KEY LEVER FULCRUM WIRE 2-41103
KEY LEVER ASSEM. 2-41222-SPRING 2-40331
TYPE BAR BELL CRANK FULCRUM WIRE 2-41108

end of type bar fulcrum wire is copper plated and must be replaced correctly or alignment may be affected.

CAUTION: DO NOT TIGHTEN FULCRUM WIRE RETAINER SCREWS 2-48010 UNLESS YOU ARE SURE THEY WILL CLEAR ENDS OF FULCRUM WIRE.

Freedom of links are of the utmost importance, because they not only cause sluggish type bars but will also cause sluggish action to the type bar segment 2-47050 when the shift keys are allowed to restore slowly. Type bar links from sixteen to twenty-one and twenty-three to twenty-eight are both straight, so they should be interchangeable. Use light keystone grease sparingly in holes for connecting links at top of type bar bell cranks - apply type oil to rear ends of connecting links with camel hair brush using care not to get oil in slots of segment. Service Department order type bar links 2-40410 and form them for position to be used, 2-41432 are center links which are ground for clearance.

The type bar restorer 2-41412 is designed in case an operator has a colliding of type bars and they stick near the type bar guide 2-41799, the operator can restore them (without getting hands inky) by pressing downward on the type bar restorer key lever knob 2-42289, which is conveniently located in the upper left front corner of the front panel 2-46861 not shown.

This restorer makes it unnecessary for the operator to touch face of type.

The type bar restorer 2-41412 is supported by pivot screws 2-40057 which are located in the upper rear corner of the right and left ribbon spool brackets. The restorer is held to its forward position by the type bar restorer spring 2-40332 which is attached to the left end of the restorer. The front end of type bar restorer spring 2-40332 is attached to stud as illustrated.

Check restorer in its normal position to see that the front lower part does not limit against the ribbon drive shaft 2-46519 (ribbon drive illustration). The forward limit for type bar restorer is the lower rear edge of type bar restorer key lever 2-41413 at point marked XX on illustration.

TOUCH REGULATOR - The touch regulator feature makes it possible for operators to adjust the key touch. If type bar bell crank spring tension lever knob 2-42289 is lowered it will cause the type bar bell crank spring anchor 2-43932 on which the type bar bell crank springs 2-40338 are attached, to move towards the rear, thus increasing the tension on the type bar bell crank spring 2-40338, which results in a snappier type bar and key lever action.

If the type bar bell crank spring tension lever knob 2-42289 which is conveniently located at the upper right corner of the front panel 2-46861 not shown is set to #1 position, the key touch will be light by as it is lowered to 2, 3, 4, or 5th positions the key touch will increase slightly and result in a faster operating machine, as mentioned above.

The type bar bell crank spring tension lever 2-43906 must be formed to the right so that rib on same will engage securely the notches of type bar bell crank spring tension lever detent 2-43907.

The type bar bell crank springs 2-40338 are all of the same tension.

Key levers should limit on upstop 2-41118. Key lever springs 2-40331 are all of the same tension.

SHIFT MECHANISM - It is very important that in adjusting the shift mechanism to hold all pivot points and connecting adjustments to a minimum of end play, yet still be free in their movement. Any excess play will result in poor alignment and shift motion.

With typewriter unit out of base, check the shift lever shaft 2-41808 for end play between pivot screws, play to be removed from shift lever shaft by pivot screws 2-40002 after loosening the shift lever shaft pivot screw nut 2-40411. Tighten nuts securely after adjustment is completed.

Check the segment shift rocker 2-43800 for end play between its pivot screws. Excess play to be removed by its pivot screw 2-40002 after loosening the shift rocker pivot screw nut 2-40411. Tighten nut securely after adjustment is made. Replace typewriter unit in base.

Loosen the front and rear segment shift stop screw nuts 2-40410 and back out the two segment shift stop screws 2-40019 until they do not limit the movement of type bar segment 2-41050 when shifting.

We will assume that all adjustments of the shift mechanism are out except those mentioned above. It is important that the adjustments are made in order as listed below:

1. Adjust rear shift toggle lever stop screw 2-40163 until shift toggle link "E" and "F" are in a straight line as shown in illustration.

2. Adjust lower shift toggle lever eccentric "C" 2-41849 with large side to rear of machine until lower case letters are on feet top and bottom. Test by striking key lightly to see if type prints same density at both top and bottom.

NOTE - After adjusting lower eccentric "C" make sure that toggle links "E" and "F" are still in a straight line. If not adjust rear shift lever stop screw 2-40163 again. Links "E" and "F" must be straight to prevent segment from bouncing downward after using shift key and to keep segment locked in position.

3. Adjust rear segment shift stop screw 2-40019 until there is no noticeable up and down play in segment when in normal position. Test by trying to move segment up and down by holding to type guide.

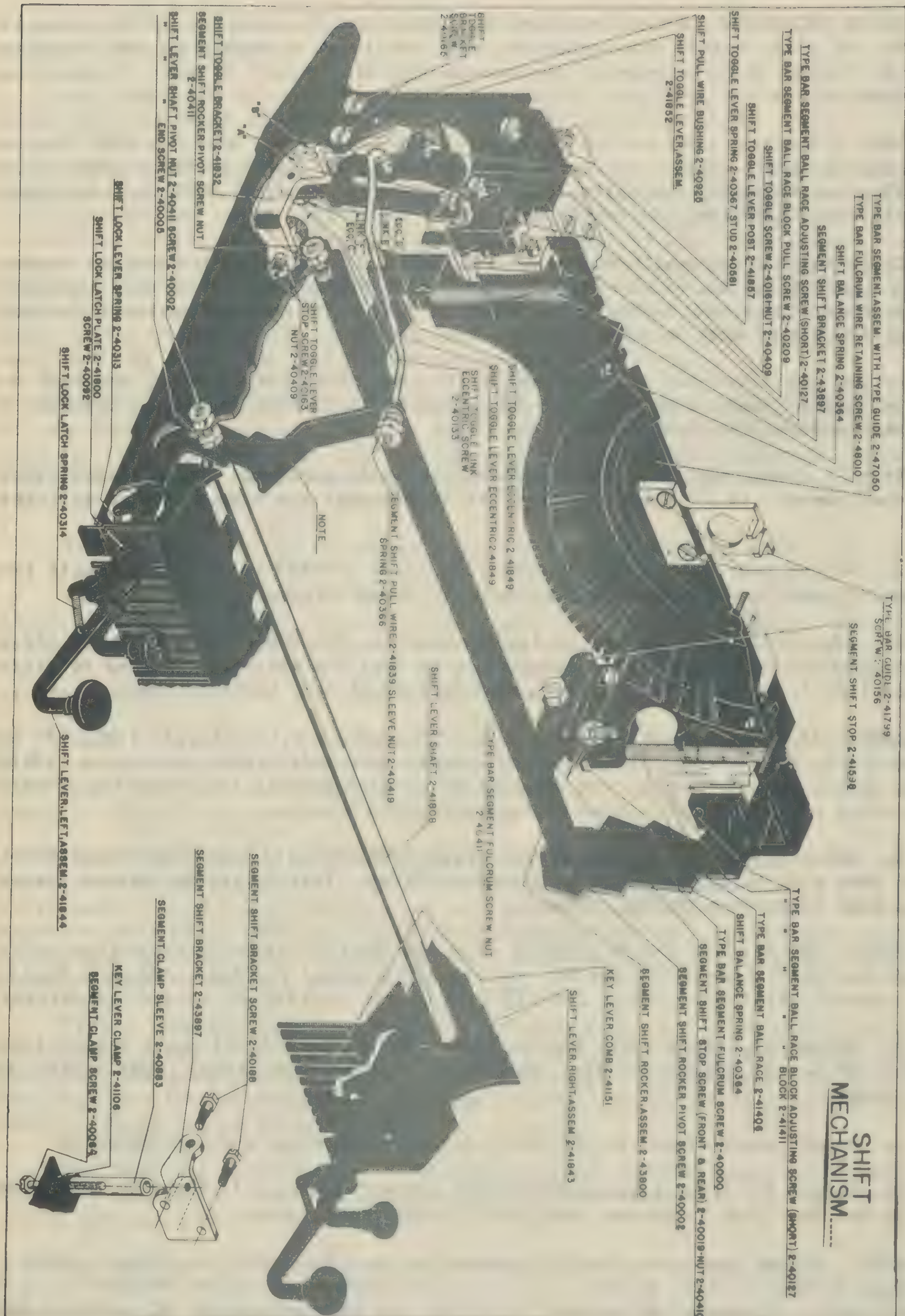
NOTE: Do not run screw 2-40019 down any further than to take play out or segment and shift keys will bind and not return to normal position. Be sure to lock rear segment shift stop screw 2-40019 by its nut 2-40410 to retain adjustment.

4. Adjust the front shift toggle lever stop screw 2-40163 until toggle links "A" and "E" are in a straight line when shift keys are depressed. (Not locked by shift lock).

5. Adjust upper eccentric "D" until motion is obtained such as HhHhHhHh.

6. Adjust the front segment shift stop screw 2-40019 until there is no noticeable up and down play in segment when shift keys are depressed.

NOTE: Do not run screw 2-40019 in too far or there will be a bind in shift keys near bottom of their travel. It may be necessary if motion "HhHhH" is off slightly after adjustment #6 is made to go back and make adjustment #5 and then make adjustment #6 a second time.


SHIFT MECHANISM.....
TYPE BAR SEGMENT ASSEM. WITH TYPE GUIDE 2-47050
TYPE BAR FULCRUM WIRE RETAINING SCREW 2-40010
SHIFT BALANCE SPRING 2-40364
SEGMENT SHIFT BRACKET 2-43897
TYPE BAR SEGMENT BALL RACE ADJUSTING SCREW (SHORT) 2-40127
TYPE BAR SEGMENT BALL RACE BLOCK PULL SCREW 2-40209
SHIFT TOGGLE SCREW 2-40161-NUT 2-40409
SHIFT TOGGLE LEVER POST 2-41857
SHIFT TOGGLE LEVER SPRING 2-40367 STUD 2-40681
SHIFT PULL WIRE BUSHING 2-40825
SHIFT TOGGLE LEVER ASSEM. 2-41852
SHIFT TOGGLE BRACKET 2-41832
SEGMENT SHIFT ROCKER PIVOT SCREW NUT 2-40411
SHIFT LEVER SHAFT PIVOT NUT 2-40411 SCREW 2-40002
" " " END SCREW 2-40005
SHIFT LOCK LEVER SPRING 2-40313
SHIFT LOCK LATCH PLATE 2-41800 SCREW 2-40092
SHIFT LOCK LATCH SPRING 2-40314
SHIFT LEVER, LEFT, ASSEM. 2-41844
SHIFT TOGGLE LEVER STOP SCREW 2-40163 NUT 2-40409
NOTE
SHIFT TOGGLE LEVER ECCENTRIC 2 41849
SHIFT TOGGLE LEVER ECCENTRIC 2 41849
SHIFT TOGGLE LINK ECCENTRIC SCREW 2-40133
SEGMENT SHIFT PULL WIRE 2-41839 SLEEVE NUT 2-40419 SPRING 2-40366
SHIFT LEVER SHAFT 2-41808
TYPE BAR SEGMENT FULCRUM SCREW NUT 2-40411
TYPE BAR GUIDE 2-41799 SCREW 2-40156
SEGMENT SHIFT STOP 2-41598
TYPE BAR SEGMENT BALL RACE BLOCK ADJUSTING SCREW (SHORT) 2-40127
" " " " BLOCK 2-41411
TYPE BAR SEGMENT BALL RACE 2-41408
SHIFT BALANCE SPRING 2-40364
TYPE BAR SEGMENT FULCRUM SCREW 2-40000
SEGMENT SHIFT STOP SCREW (FRONT & REAR) 2-40019-NUT 2-40410
SEGMENT SHIFT ROCKER PIVOT SCREW 2-40002
SEGMENT SHIFT ROCKER, ASSEM. 2-43800
KEY LEVER COMB 2-41151
SHIFT LEVER, RIGHT, ASSEM. 2-41843
SEGMENT SHIFT BRACKET SCREW 2-40188
SEGMENT SHIFT BRACKET 2-43897
SEGMENT CLAMP SLEEVE 2-40883
KEY LEVER CLAMP 2-41106
SEGMENT CLAMP SCREW 2-40084

Check carefully the two shift toggle lever eccentric screws 2-40133 to see that they are tight. If loose, the eccentrics will move, causing motion and "on feet" adjustments to be thrown out.

The shift key levers right and left should now be adjusted for height. The correct position for them is determined by having shift key tops 1/16 inch above the lower bank of key tops. This adjustment is made by loosening the shift pull wire nut and adjusting the shift pull wire sleeve nut 2-40419 to rear to raise the shift keys or vice versa. After the correct height of shift keys is obtained, lock the shift pull wire sleeve in place with shift pull wire nut 2-40418.

When the above adjustment is completed check the motion "HhHhHh" again and also try segment for being locked in upper position (Normal) as mentioned before. If motion is off or segment is not locked as it should be, check the left shift key lever at point marked "NOTE", as lever may be limiting on the tabulator key shaft. If this is the case form the shift lever for clearance at "NOTE" position.

The shift lock latch plates 2-41800 right and left are mounted to the key lever comb 2-41151 with two mounting screws 2-40092 in each lock plate. The holes in these plates are elongated. The shift lock latch plates should be set low enough so there will be no variation in the motion of upper and lower case letters. To be tested by locking right and left shift key locks separately and striking off motion "HhHhHhHh".

Shift lock plates must also be set even. Make the test for this by locking both shift lock keys. Now release the locks by depressing the left shift key. The lock on the left should release first and the one on the right should release immediately after. Make this same test but release the locks by depressing the right shift key lever. Tighten the shift lock plate mounting screws 2-40092 after adjustments have been made.

The tension of the shift mechanism is controlled by the two shift balance springs 2-40364 which are hooked to the lower front part of the type bar segment 2-47050. The upper ends of these springs are attached to brackets as illustrated. The shift toggle lever spring 2-40367 helps to restore the shift mechanism and also holds the shift toggle lever 2-41852 in normal position to prevent rebounding of type bar segment 2-47050.

ESCAPEMENT & TYPE BAR UNIVERSAL BAR - Loosen the screw 2-40114 for the escapement link lock arm 2-42605 at bottom of escapement rocker 2-42650. Remove nut 2-40411 and screw 2-40122 that holds escapment rocker bracket 2-42690 to frame. Take escapement rocker bracket 2-42690 from machine.

There are certain adjustments pertaining to this escapement which should be made when escapement mechanism is out of the machine. Remove one of the escapement rocker pivot screws 2-40164 and take out the escapement rocker 2-42650 complete. (Do not lose the escapement rocker spring 2-40300.) Remove the escapement loose dog silencer stop screw 2-40081 and nut 2-40409 from the escapement rocker bracket 2-42690. Remove the escapement wheel 2-42755 by taking out the escapement wheel bearing screw 2-40149, nut 2-40411 and washer 2-40958.

On the rear side of the escapement wheel 2-42755 will be found the loose dog silencer 2-42623, silencer friction spring 2-42606 and friction spring collar 2-40919. The purpose of the loose dog silencer 2-42623 is to eliminate noise by holding the loose dog clear of the escapement wheel teeth as the carriage is being returned, therefore, only enough tension should be put on the silencer friction spring 2-42006 to obtain this result.

The correct tension can be obtained by loosening set screw 2-40115 and adjusting collar 2-40919, which is threaded. Care should be taken on this adjustment, if collar is screwed on too far it will slow down carriage speed and make carriage return heavy. After adjusting the collar make sure that rear side of collar does not extend beyond back edge of escapement wheel 2-42755, also see that set screw 2-40115 in collar is tight.

A small amount of typewriter oil should be placed on escapement wheel bearing screw 2-40189 before mounting escapement wheel to bracket.

Hold escapement wheel 2-42755 on to the escapement rocker bracket 2-42690 by escapement wheel bearing screw 2-40189, and hold its position by washer 2-40953 and nut 2-40411. Escapement wheel must be free to turn on screw but have no noticeable end play. Wheel should also run true.

Replace the loose dog silencer stop screw 2-40081, making sure that it is through slot of loose dog silencer 2-42623 and not run in far enough to bind rear side of escapement wheel 2-42755. This clearance can be seen by turning the escapement wheel until hole is in line with the front end of loose dog silencer stop screw 2-40081.

The escapement loose dog carrying arm screw 2-40008 should be adjusted for minimum amount of play. Test the loose dog 2-42624 for moving freely in the loose dog guide 2-42630, both up and down and to the right or left, check the escapement loose dog spring 2-40326 for tension. The correct distance between the loose dog and fixed dog is from .043 to .045. This clearance will control the safety zone which will be mentioned later.

Replace the escapement rocker 2-42650 on the escapement rocker bracket 2-42690 and insert pivot screw 2-40164, remove all end play but have escapement rocker free between its pivot points. Insert the escapement rocker spring 2-40300. The escapement rocker spring adjusting screw 2-40101 head should be backed out until it is against the escapement rocker bracket 2-42690. If necessary this screw can be adjusted to put more tension on the escapement rocker. The lower escapement rocker stop screw 2-40100 should be adjusted until the front edge of loose dog is set .015 to .020 to the rear of front edge of escapement wheel tooth. At this point turn the escapement wheel and observe the amount of hold that the loose dog silencer 2-42623 has on rear edge of loose dog. If the loose dog is adjusted too far forward on the escapement wheel teeth the silencer will not be able to engage loose dog correctly, and also, type bars would pick up the escapement universal bar too soon, which affects the key touch.

Hold the escapement wheel 2-42755 against the loose dog, causing loose dog to limit against the escapement rocker and see that the face of the loose dog, where it contacts the teeth of the escapement wheel, are flush against each other. This condition is commonly known as 6 o'clock and is adjusted by moving the escapement rocker pivot screws 2-40164 to the right or left to get the desired results. After this condition is obtained check escapement rocker 2-42650 for free with no end play.

Replace the escapement mechanism complete on the machine, making sure that the hole in lower end of tabulator friction screw arm 2-42412 is placed (as shown in tabulator illustration) on the tabulator friction bail 2-42382. Hold downward on escapement bracket when tightening the escapement rocker bracket screw 2-40122 and nut 2-40411. Failing to do so may change depth of mesh of escapement wheel pinion with letter spacing rack. Place escapement link into position in escapement rocker, retaining it with escapement link lock arm 2-42605, by tightening its screw 2-40114.

Push the "H" type bar to the ribbon, the escapement trip should take place as face of type touches ribbon. Adjust by loosening escapement trip nut 2-40408 and adjust escapement link sleeve 2-42629 until desired result is obtained. Lock sleeve with nut.

After obtaining trip, hold type bar against cylinder and test lower part of escapement rocker for small additional movement forward. The upper escapement stop screw 2-40100 should not limit movement of escapement rocker 2-42650. Make this test for same condition with space bar depressed against its down stops. If not the same, check carefully the space bar adjustments and if rocker still limits against upper stop screw 2-40100, back it out slightly.

Next, test the escapement safety zone. Raise the "H" type bar slowly by hand until escapement trip takes place at the ribbon, then allow the type bar to restore to front of machine slowly, the second trip of escapement should occur when the face of the type is 1/2" to 9/16" away from the ribbon. This, as mentioned before, is controlled entirely by distance between loose dog and fixed dog which is .043 to .045. If the distance is more than 9/16" there is danger of the operator piling one letter on top of another. If less than 1/2" there is danger of skipping between letters. If the escapement loose dog carrying arm screw 2-40008 is too tight it will prevent loose dog from stepping to the left, thereby causing machine to pile letters occasionally.

The Pica (10 pitch) escapement has fifteen (15) teeth in the wheel and fifteen (15) teeth in the pinion. Being an even number of teeth in both members, the escapement can be removed and replaced without affecting the setting of the scales and racks.

The Elite (12 pitch) escapement has eighteen (18) teeth in the wheel and fifteen (15) teeth in the pinion. When it is found necessary to remove the escapement unit or carriage from an Elite machine, move the carriage to the left until right carriage end casting limits against carriage end stop screw 2-40290, then mark the escapement wheel so that when the unit is replaced the teeth in the pinion will go into mesh with the teeth in the carriage feed rack in the same position as they were before escapement or carriage was removed from the machine. If the teeth are not positioned as stated it will be found necessary to re-set the margin stop rack, carriage scales and tabulator rack.

REMINGTON MODEL 17 WITH E, F, AND G CARRIAGES ELITE TYPE

SETTING OF ESCAPEMENT ON MACHINES ABOVE J-29000 - The above listed machines are sent to the field with the carriages off due to their extreme length and added weight. The factory has received complaints from the field stating that after placing carriages on the machines it was found necessary to readjust the margin stop rack, tabulator drop, tabulator set bracket, etc. To overcome these complaints, place the carriages on the machines and remove the escapement complete.

There are two holes in the escapement wheel and when the escapement rocker body is set for 6 o'clock position the tooth on the escapement wheel directly below the largest of the two holes is placed against the loose dog. While holding this tooth firmly against the loose dog, the rocker body is set to the right or left until the face of the tooth on escapement wheel and face of loose dog are flush with each other. When checking for this condition, care must be taken to see that the small hole of the escapement wheel is in direct line with the small hole in escapement bracket. It must be close enough so that a locating pin (which can be made from a finishing nail about 3/32" diameter or any round stock that is .098 to .100 in

diameter) can be inserted through the escapement bracket hole and on into the hole of escapement wheel. It should be inserted until it is flush with the front edge of the escapement wheel. In the illustration it protrudes in order to see it more clearly.

Leave the locating pin in the holes as just explained. Hold down on the margin release key and push the carriage to the left (looking at machine from rear) until the carriage end plate limits against its limit screw. Hold the carriage against this screw and insert the escapement to position at rear of machine. After the escapement has been mounted remove the locating pin and check the scale at front of machine. It should be at "O" position on the scale unless the rocker body was operated while putting the escapement into place. If so return the carriage to "O" position on scale and see that the holes for locating pin line up.

The reason for the pin is to definitely hold the escapement wheel at a fixed position so that the proper tooth of the pinion will mesh up with the proper tooth of the letter spacing rack. This in turn will bring the machine back to the original factory settings.

The adjustments listed above are followed by the factory on all length carriages of both Pica and Elite machines. On the Pica escapement wheels there are 15 teeth on the escapement wheel and 15 teeth on the pinion. On Elite machines there are 15 teeth on the pinion and 18 teeth on the escapement wheel. This is why we have to watch the settings on the Elite machines because it is impossible to have the same relationship between the teeth on the pinion and the teeth on the escapement wheel all the way around.

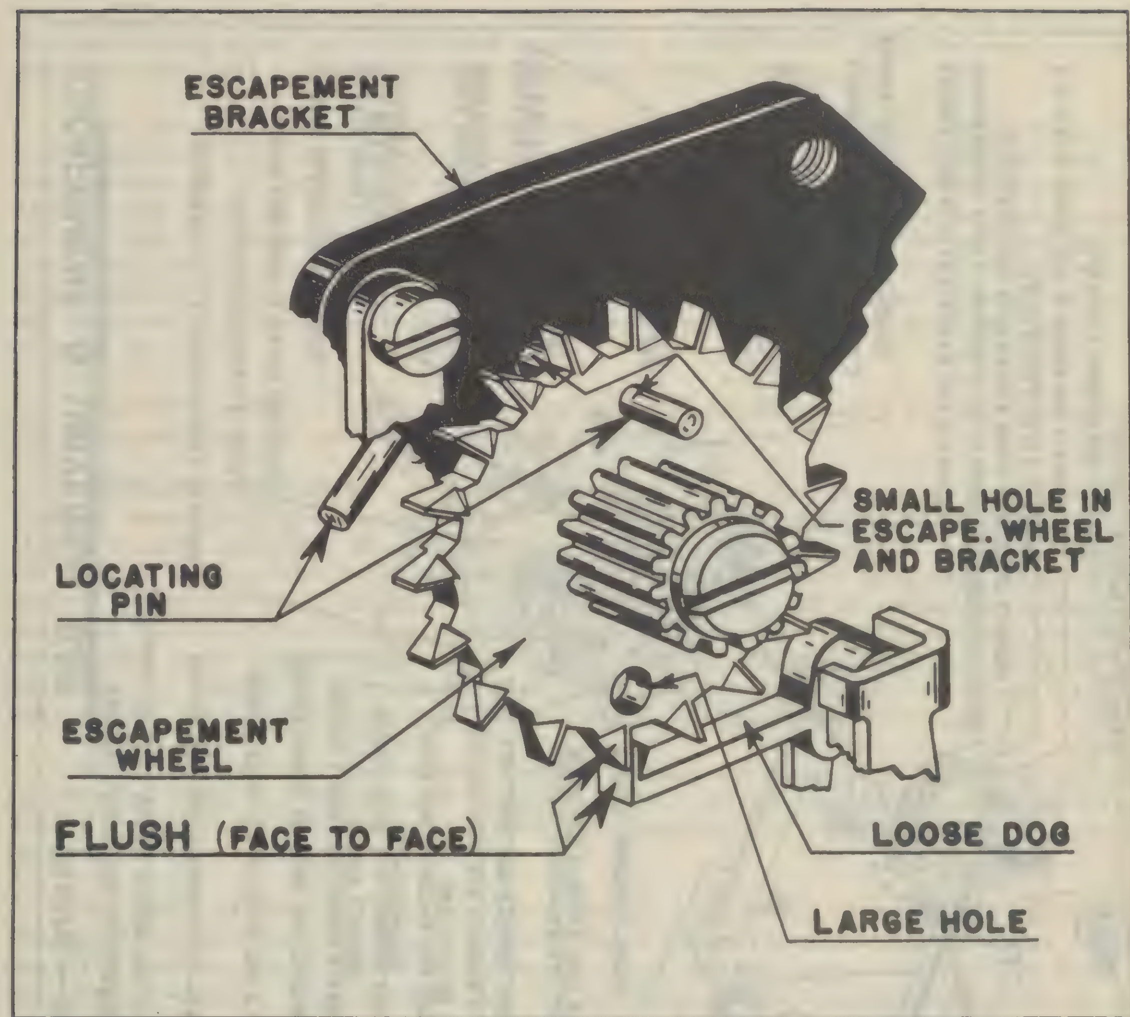
TYPE BAR UNIVERSAL BAR - With all the escapement adjustments made, we will now test the machine, to see if the type bar unversal bar 2-41647 is correctly adjusted.

We will assume that the type bar universal bar oscillator bracket screws 2-40128 are tight, also that the adjusting plate pivot screws 2-40004 and adjusting plate screws 2-40133 are tight and that the universal bar oscillator pivot screws 2-40060 have been adjusted for free but no end play in the type bar universal bar oscillator 2-41428, and adjusted in such a position that the type bar universal bar guide stud will be free in guide hole of type bar segment. The type bar universal bar oscillator spring 2-42862 gives the oscillator sufficient tension to hold the type bar universal bar to its forward position.

To test, raise the type bar "H" and see that the escapement takes place as face of type touches ribbon, (as previously instructed). This being correct we will raise by hand type bars #1 and #42, to see that the escapement takes place as face of type touches ribbon. If all three type bars escape at the ribbon the universal bar is correctly adjusted.

Example #1: We will assume that the escapement on the "H" type bar is correct, but on the #1 type bar the escapement takes place 1/8" before it touches the ribbon. It will be necessary in this case to loosen the adjusting plate screw 2-40133 and locate the left adjusting plate 2-43945 to the rear slightly; this will make the escapement on the #1 type bar closer to the ribbon. After locating the left adjusting poate, always check the #42 type bar.

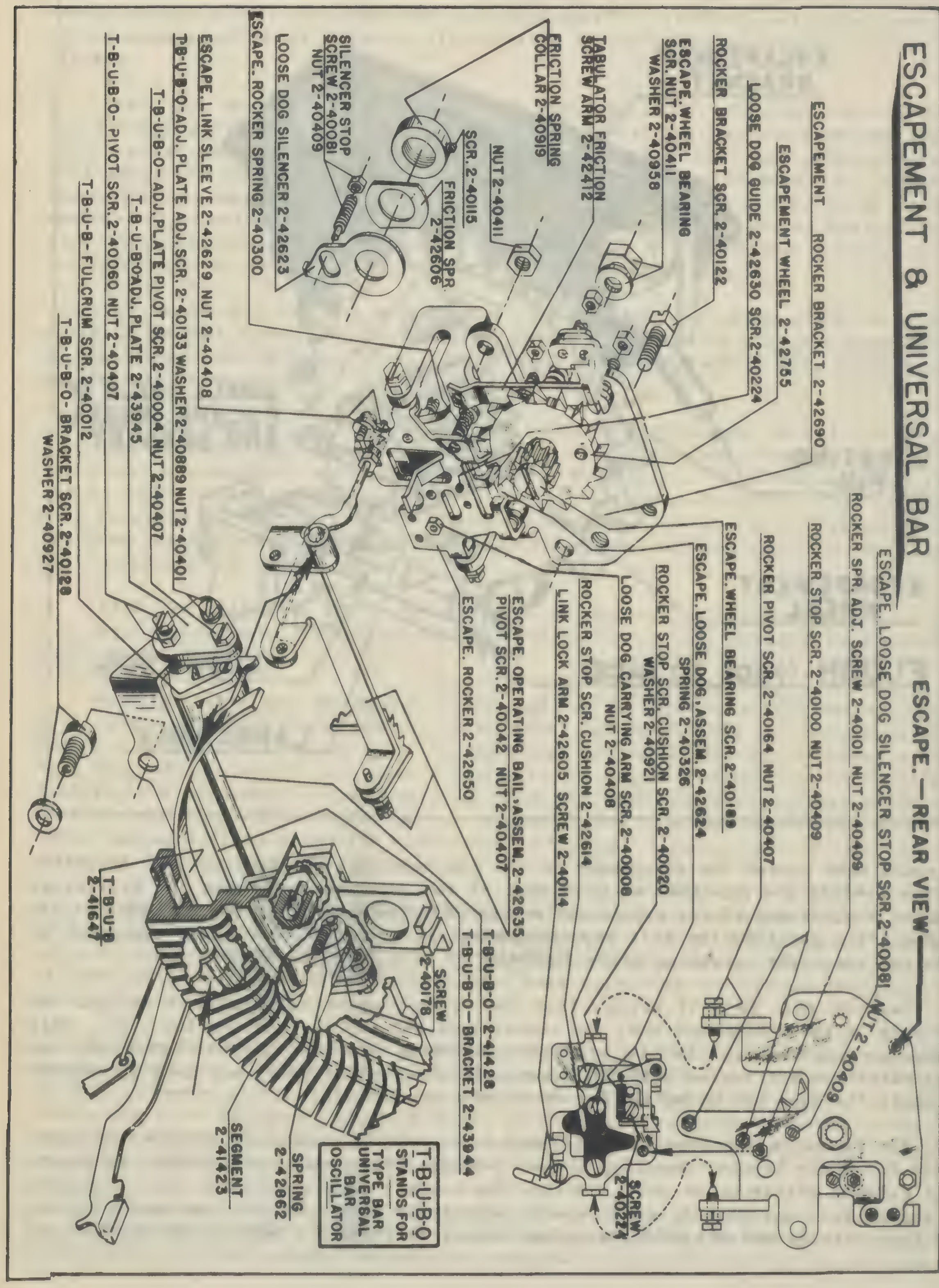
When moving the left adjusting plate to the rear the escapement on the #42 type bar will occur a little sooner than it did before, likewise, if the left adjusting plate had been moved forward to make the escapement on the#1 type bar escape sooner,



it would have caused the escapement on the #42 type bar to escape later. Adjusting plates 2-43945 are provided at both ends of the type bar universal bar oscillator bracket 2-43944 and if the escapement on the #42 type bar is not taking place at the ribbon after locating the left adjusting plate we will follow the same procedure in locating the right adjusting plate 2-43945.

Example #2: We will assume that the escapement on type bars #1 and #42 are escaping at the ribbon and that the center type bar "H" is escaping too late. This condition can be corrected by slightly loosening the two type bar universal bar oscillator bracket screws 2-40128 (typewriter unit out of base) and moving downward slightly the type bar universal bar oscillator bracket.

The holes in the type bar universal bar oscillator bracket 2-43944 are oversized for their bracket mounting screws 2-40128, which makes it possible to locate this bracket either up or down. Moving the bracket down will cause the escapement on the center type bars to occur sooner and at the same time the escapement on the end type bars #1 and #42 will take place later, therefore, a very slight movement of


ESCAPEMENT & UNIVERSAL BAR
ESCAPE.—REAR VIEW
ESCAPEMENT ROCKER BRACKET 2-42690
ESCAPEMENT WHEEL 2-42755
LOOSE DOG GUIDE 2-42630 SCR. 2-40224
ROCKER BRACKET SCR. 2-40122
ESCAPE. WHEEL BEARING SCR. NUT 2-40411 WASHER 2-40958
TABULATOR FRICTION SCREW ARM 2-42412
FRICTION SPRING COLLAR 2-40919
NUT 2-40411
SCR. 2-40115
FRICTION SPR. 2-42606
SILENCER STOP SCREW 2-40081 NUT 2-40409
LOOSE DOG SILENCER 2-42623
ESCAPE. ROCKER SPRING 2-40300
ESCAPE. LINK SLEEVE 2-42629 NUT 2-40408
T-B-U-B-O-ADJ. PLATE ADJ. SCR. 2-40133 WASHER 2-40889 NUT 2-40401
T-B-U-B-O-ADJ. PLATE PIVOT SCR. 2-40004 NUT 2-40407
T-B-U-B-O-ADJ. PLATE 2-43945
T-B-U-B-O- PIVOT SCR. 2-40060 NUT 2-40407
T-B-U-B- FULCRUM SCR. 2-40012
T-B-U-B-O- BRACKET SCR. 2-40128 WASHER 2-40927
ESCAPE. LOOSE DOG SILENCER STOP SCR. 2-40081 NUT 2-40409
ROCKER SPR. ADJ. SCREW 2-40101 NUT 2-40409
ROCKER STOP SCR. 2-40100 NUT 2-40409
ROCKER PIVOT SCR. 2-40164 NUT 2-40407
ESCAPE. WHEEL BEARING SCR. 2-40189
ESCAPE. LOOSE DOG, ASSEM. 2-42624 SPRING 2-40326
ROCKER STOP SCR. CUSHION SCR. 2-40020 WASHER 2-40921
LOOSE DOG CARRYING ARM SCR. 2-40006 NUT 2-40408
ROCKER STOP SCR. CUSHION 2-42614
LINK LOCK ARM 2-42605 SCREW 2-40114
ESCAPE. OPERATING BAIL, ASSEM. 2-42635 PIVOT SCR. 2-40042 NUT 2-40407
ESCAPE. ROCKER 2-42650
T-B-U-B-O—2-41428
T-B-U-B-O—BRACKET 2-43944
SCREW 2-40178
T-B-U-B 2-41647
SCREW 2-40227
T-B-U-B-O STANDS FOR TYPE BAR UNIVERSAL BAR OSCILLATOR
SPRING 2-42862
SEGMENT 2-41423

the oscillator bracket 2-43944 is necessary. If the escapement on the center type bar was taking place before the end type bars, it would have been necessary to move the type universal bar oscillator bracket up instead of down.

The type bar universal bar will have to be checked for proper adjustment with the typewriter unit in the base, but in case the unit is removed from the base for convenience of adjusting the universal bar, it is well to hold the type bar "H" against the anvil on the segment and while holding it in this position make a mark on the type bar universal bar guide stud and then hold type bars #1 and #42 against the anvil to see that they throw the guide stud the same distance, which can be determined by referring to the mark on the guide stud. As stated before, the type bar universal bar would have to be checked for proper adjustment with the typewriter unit in the base.

Inasmuch as the type bar segment can be removed and washed without disturbing the universal bar, it should seldom need adjusting.

TABULATOR MECHANISM - The depressing of the tabulator key bar 2-42415, through connecting link 2-42440 causes the rear end of tabulator bell crank 2-42414 (left) to move upward. The tabulator bell crank adjusting screw 2-40118 contacts the bottom of the tabulator stop blade 2-42510, and as the tabulator blade moves upward it carries the tabulator friction bail 2-42382, which transmits a downward movement to lip "B" on the escapement loose dog release 2-46530, which lowers the escapement loose dog 2-42624 out of the escapement wheel 2-42755, permitting the carriage to tabulate until tabulator stop 2-47500 (which is depressed) limits against the top of tabulator stop blade 2-42401, stopping the carriage.

When the tabulator bar is released the escapement loose dog 2-42624 is allowed to restore into the escapement wheel 2-42755, before the tabulator stop blade 2-42501 clears the tabulator stop, thus preventing the carriage from tabulating further.

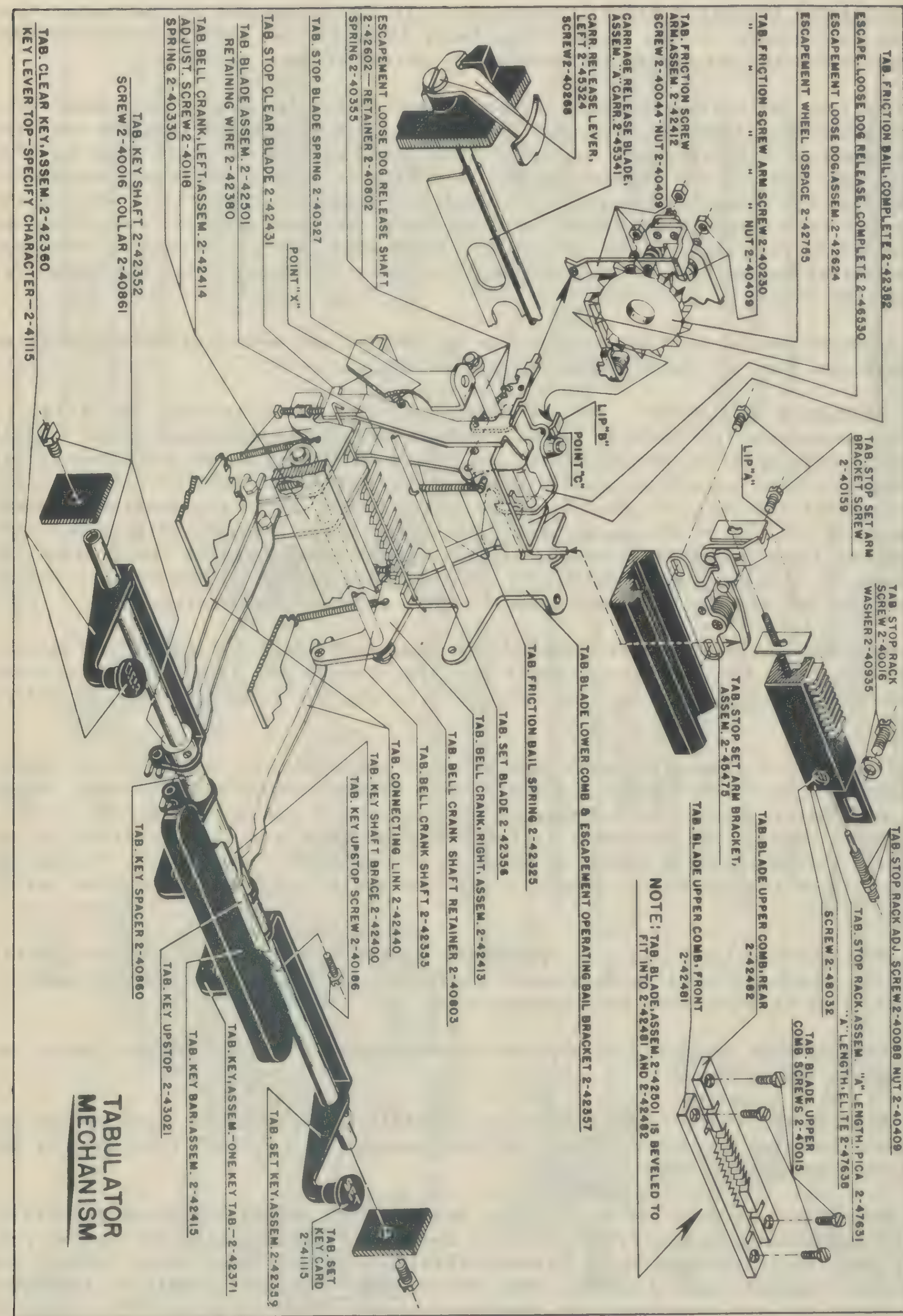
The speed of the carriage on tabulation is controlled by friction type brake. The tabulator friction screw arm 2-42412 has a brass friction screw 2-40044 in it, near the center, with the flat headed portion of the screw facing rear side of escapement wheel. The movement of the friction screw arm is controlled by the tabulator friction bail 2-42382, as shown on illustration. The amount of brake of friction is controlled by the tabulator friction spring 2-42867 and friction spring screw 2-40101.

When the tabulator set key 2-42359 is operated the tabulator stop directly above the clear key will be depressed, therefore, it may be cleared out again in case of error by depressing the tabulator clear key 2-42360.

The tabulator stops may be restored by depressing the clear key and moving the carriage to the right.

ADJUSTMENTS - The tabulator key bar 2-42415, (or tabulator keys on ten key machine) tabulator clear key 2-42360 and tabulator set key 2-42359 limit against the tabulator key upstop 2-43021.

When the above keys are in position as described, adjust the screw 2-40118 in the tabulator bell cranks (right 2-42413 and left 2-42414) until the screws just clear the tabulator stop clear blade 2-42431, tabulator stop blade 2-42501 and tabulator stop set blade 2-42356. When the tabulator key bar 2-42415 or tabulator stop clear key are depressed the tabulator blades limit at point "X", shown on



TAB. FRICTION BAIL, COMPLETE 2-42382
ESCAPE. LOOSE DOG RELEASE, COMPLETE 2-46550
ESCAPEMENT LOOSE DOG, ASSEM. 2-42624
ESCAPEMENT WHEEL 10SPACE 2-42765
TAB. FRICTION SCREW ARM SCREW 2-40230
" " " " NUT 2-40409
TAB. FRICTION SCREW ARM, ASSEM. 2-42412
SCREW 2-40044-NUT 2-40409
CARRIAGE RELEASE BLADE, ASSEM. "A" CARR. 2-45341
CARR. RELEASE LEVER, LEFT 2-45324
SCREW 2-40268
ESCAPEMENT LOOSE DOG RELEASE SHAFT 2-42602—RETAINER 2-40802
SPRING 2-40355
TAB. STOP BLADE SPRING 2-40327
POINT "X"
TAB. STOP CLEAR BLADE 2-42431
TAB. BLADE ASSEM. 2-42501
RETAINING WIRE 2-42380
TAB. BELL CRANK, LEFT, ASSEM. 2-42414
ADJUST. SCREW 2-40118
SPRING 2-40330
TAB. KEY SHAFT 2-42352
SCREW 2-40016 COLLAR 2-40861
TAB. CLEAR KEY, ASSEM. 2-42360
KEY LEVER TOP-SPECIFY CHARACTER—2-41115
LIP "B"
POINT "C"
LIP "A"
TAB. STOP SET ARM BRACKET SCREW 2-40159
TAB STOP RACK SCREW 2-40016
WASHER 2-40935
TAB. STOP SET ARM BRACKET, ASSEM. 2-45475
TAB. BLADE LOWER COMB & ESCAPEMENT OPERATING BAIL BRACKET 2-42357
TAB. FRICTION BAIL SPRING 2-42325
TAB. SET BLADE 2-42356
TAB. BELL CRANK, RIGHT, ASSEM. 2-42413
TAB. BELL CRANK SHAFT RETAINER 2-40803
TAB. BELL CRANK SHAFT 2-42353
TAB. CONNECTING LINK 2-42440
TAB. KEY SHAFT BRACE 2-42400
TAB. KEY UPSTOP SCREW 2-40186
TAB. KEY SPACER 2-40860
TAB. KEY UPSTOP 2-43021
TAB. KEY BAR, ASSEM. 2-42415
TAB. KEY, ASSEM.-ONE KEY TAB.-2-42371
TAB. SET KEY, ASSEM. 2-42359
TAB. SET KEY CARD 2-41115
TAB. STOP RACK ADJ. SCREW 2-40088 NUT 2-40409
TAB. STOP RACK, ASSEM. "A" LENGTH, PICA 2-47631
"A" LENGTH, ELITE 2-47638
SCREW 2-48032
TAB. BLADE UPPER COMB SCREWS 2-40015
TAB. BLADE UPPER COMB, REAR 2-42482
TAB. BLADE UPPER COMB, FRONT 2-42481
NOTE: TAB. BLADE, ASSEM. 2-42501 IS BEVELED TO FIT INTO 2-42481 AND 2-42482
TABULATOR MECHANISM

When the carriage is at the left margin, there should be a distance of .060 between the margin stop 2-45823 and the margin stop lever, too much clearance between these parts at the margin will result in the carriage "banking over" or going one space beyond the margin, as set. To adjust, shorten the distance between the margin stop and the margin stop lever by loosening lock nut 2-40465 and backing out on the left margin stop rack pivot screw 2-40259 and loosening lock nut 2-40465 for the right margin stop rack pivot screw and run it in to remove end play.

Margin stop rack 2-46107 must be free to pivot on these screws but without end play. Lock nuts 2-40465 to be tight when adjustment is completed. If there is not enough distance between the margin stop 2-45823 and the margin stop lever the result would be irregular margin, also it would not be possible to back space into the first space of left margin. In this case we would adjust the margin stop rack 2-46107 to the right by its pivot screws.

Move the carriage until 20 on the carriage scale 2-46100 is in line with the indicator on type guide. At this point press to the right the margin stop lever until it limits on its bracket, while holding it in this position, see that the line lock trip bail 2-45153 just clears its stop screw 2-40172 slightly. Line lock trip bail must be free on its pivot screws 2-40248. Loosen nut 2-40409 for the line lock bell crank throw in lever screw 2-40153 and back this screw out 5 or 6 turns. Loosen nut 2-40409 on the line lock bell crank eccentric 2-42714 and adjust this eccentric until it will hold the line lock trip bail 2-45153 to its highest position and hold the eccentric to this adjustment by its lock nut 2-40409; next set the margin stop 2-45821 at 75 and adjust margin stop rack pull link eccentric 2-42714 until the bell rings only onee.

If the bell rings twice it indicates that point "A" on margin stop is setting too high, therefore the margin stop rack eccentric 2-42714 will have to be adjusted with the large side further to the top, if the eccentric is all the way to the top and the margin stop is not low enough it will be necessary to form the margin stop rack link bracket 2-45832 slightly lower.

After adjusting the margin stop rack for the bell to ring correctly, adjust the line lock bell crank throw in lever screw 2-40153 until it will cause the line lock universal bar 2-42706 to lock all of the key levers, and space bar at 5 or 6 spaces (elite will have 7 or 8) after the bell rings. After this adjustment is made, be sure that the nut 2-40409 on the line lock bell crank throw in lever screw 2-40153 is tight. The line lock universal bar 2-42706 must be free on its pivot screws 2-40023. The lip on the bottom of the line lock universal bar will normally clear the key levers as they are depressed 1/16". This clearance is controlled by the line lock universal bar pull wire sleeve 2-40420 and nut 2-40408. If trouble is experienced in adjusting bell and line lock, check the following: Line lock trip bail 2-45153 must be level and the tension of bell ringer toggle spring 2-40362 and margin stop lever return spring 2-40398 are important.

When the margin stop lever is to the right of the margin stop 2-45823, (i.e. making notations outside of the left margin) as the margin stop lever engages the bevel on the underside of the margin stop 2-45823 the margin stop lever should not yield to the right far enough to cause the line lock universal bar to lock the key levers or ring the bell. The above condition can be obtained by stoning off any burrs from that part of the margin stop lever that engages the margin stop, also remove the margin stop and buff the underside of it to a smooth finish. If after doing this you have still not accomplished the desired results it is then a matter of balancing up the spring tension of the margin stop lever return spring 2-40398 and margin release bell crank spring 2-40363. If margin release bell crank spring

illustration. Tabulator key bar 2-42415 or tabulator clear key 2-42360 are depressed separately, the tops of the tabulator stop blade 2-42501 and the tabulator stop clear blade 2-42431 should clear stops in tabulator stop rack 2-47631 about 1/32".

If this condition does not exist and tabulator blades are limiting at point "X" shown on illustration; then loosen the two tabulator stop rack mounting screws 2-40016 and hold tabulator stop rack up to position and tighten screws. Depress set key 2-42359 and set up a continuous number of tabulator stops 2-47500 in tabulator rack. Depress the tabulator key bar 2-42415 slowly and observe whether the tabulator stop blade 2-42501 comes up centrally between two tabulator stops 2-47500. This adjustment is obtained by loosening the two tabulator rack mounting screws 2-40016 and screwing in or out of the tabulator stop rack adjusting screw 2-40088. Be sure that the right end of tabulator stop rack is against this adjusting screw and that the two tabulator stop rack screws 2-40016 are tight and lock nut for adjusting screw 2-40088 is set when adjustment is completed.

After locating the tabulator stop rack 2-47631, we will set the tabulator stop set arm bracket 2-45475. Lip "A" on top of the tabulator set arm bracket must contact the tops of tabulator stops 2-47500 centrally, and should not set up more than one stop at a time. To adjust, loosen the two tabulator set arm bracket screws 2-40159 and locate set bracket to right or left as desired. Tighten the two tabulator set arm bracket screws 2-40159.

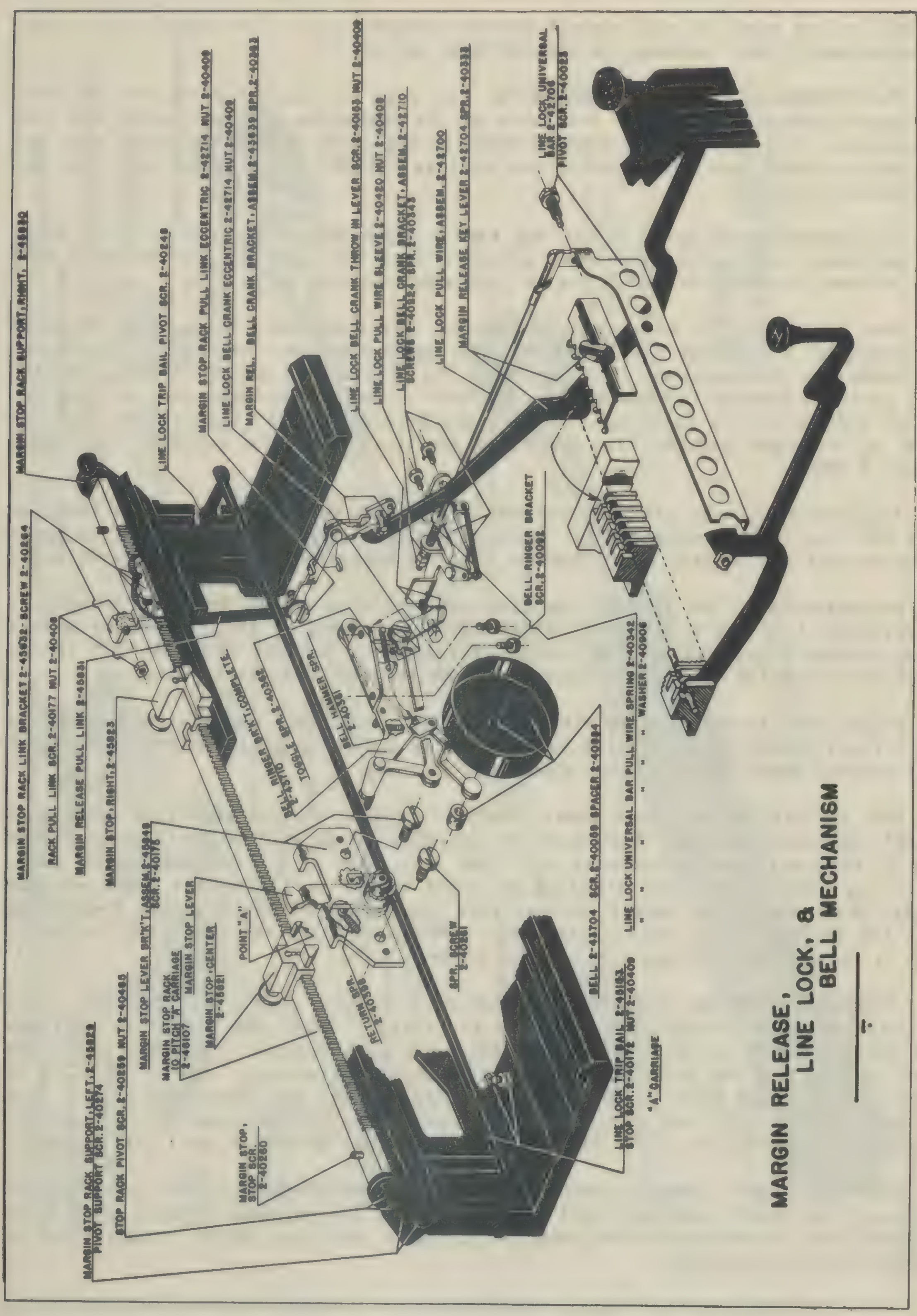
When tabulator set key is operated and tabulator stop set blade limits at point "X" but the tabulator stops are not fully depressed, it indicates that lip "A" should be formed down slightly. Do not form lip "A" too low as it may rub on the tops of tabulator stops.

Tabulator key bar 2-42415 depressed, loose dog 2-42624 should clear escapement wheel, adjust by forming loose dog release 2-46530 at point "C". Lip "B" on escapement loose dog release should not limit and prevent loose dog 2-42624 from coming to correct height.

Adjust tabulator friction arm support mounting screw 2-40230 and brass friction screw 2-40044, so that head of brass friction screw will contact rear side of escapement wheel flush when tabulator bar 2-42415 is depressed. Tabulator friction bail 2-42382 when in normal position must hold brass friction screw clear of escapement wheel. Adjust by forming the lower end of tabulator friction screw arm 2-42412 toward front of machine. Brass friction screw must clear the escapement wheel 2-42755 slightly, otherwise it would cause a sluggish moving carriage when operator is typing. If brass friction screw clears escapement wheel too much, it may not move forward and engage escapement wheel when tabulating.

In case tabulator stop blade hangs on tabulator stop 2-47500 and does not restore, loosen nut 2-40409 on tabulator friction arm support screw 2-40230 and back screw toward front of machine slightly - this will relieve pressure and allow tabulator blade to restore. Lock nut 2-40409 after adjustment is completed and check tabulator brake adjustments.

MARGIN RELEASE, LINE LOCK AND BELL MECHANISM - Assuming that the letter spacing rack 2-45968 has been adjusted for proper depth of mesh with the escapement wheel pinion (refer to carriage adjustments) and that the escapement rocker has been set for 6 o'clock position (refer to escapement adjustments). Set the margin stop 2-45823 for left margin at 10, return the carriage to the right until margin stop lever limits against the margin stop.



MARGIN RELEASE, LINE LOCK, & BELL MECHANISM

2-40363 is too weak it will permit uneven margins due to the margin stop rack vibrating upward when carriage is slammed back against it.

PLATEN ROLL, LINE SPACE MECHANISM - In case of trouble with the variable line space mechanism, see that the parts of the mechanism are lubricated and that the variable line space clutch dogs 2-45093 do not stick in their slots. Also see that the variable line space clutch dog springs 2-42866 are in good condition and functioning properly.

The variable line space clutch dog cams 2-45069 should be free in their movement and under good spring tension, also see that the teeth of the variable line space ratchet (2-45050-30 tooth) are in good shape and not worn.

When adjusting the line space mechanism, see that there is no over throw or under throw of the Platen Roll after the line space has been completed. To prevent this condition the position of the roll on the line space ratchet detent arm (30-tooth ratchet) 2-45126 is correct when the roll is setting between two teeth of the ratchet 2-45040 at the time that the line space lever 2-45137 has reached its full travel to the right and the line space pawl is limiting on the variable line space ratchet 2-45040.

Adjustment is made with the ratchet detent arm bearing eccentric 2-40993 on which the line space ratchet detent arm 2-45126 is mounted. Tighten the line space ratchet detent arm bearing screw 2-40294 when the adjustment has been properly made.

The pressure of the roll on the line space ratchet detent arm 2-45126 against the variable line space ratchet 2-45040 can be adjusted by the line space detent spring anchor eccentric 2-40994 which will locate the line space detent spring anchor plate 2-45125 to front or rear until the desired pressure is obtained.

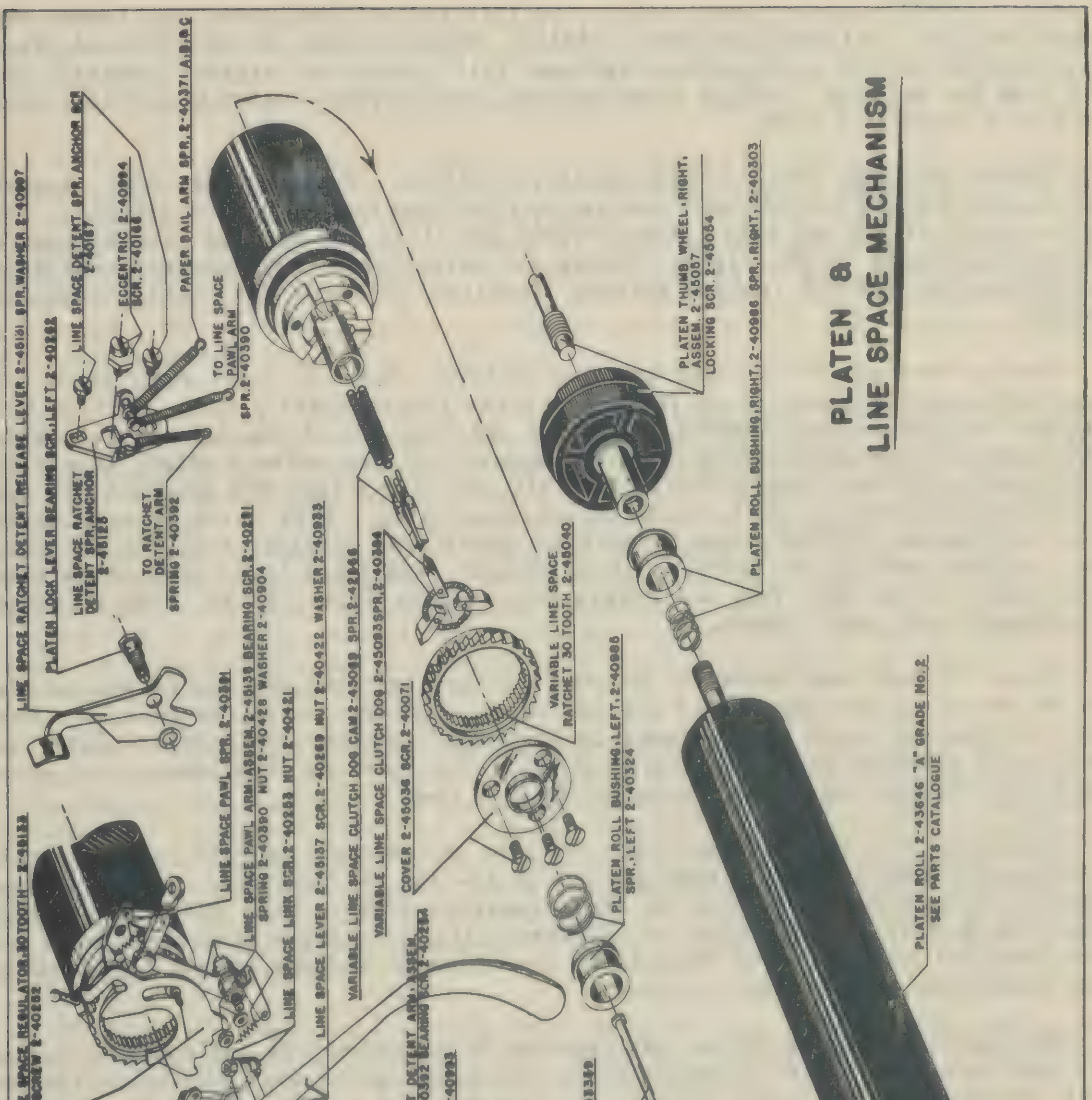
Platen roll to turn freely with no noticeable end play, end play is controlled by the right platen thumb wheel 2-45057 which is locked to position by platen thumb wheel locking screw 2-45054 after adjustment is made.

When the left platen thumb wheel 2-43359 is tight, the variable line space knob 2-43357 must have end play, test with the variable set in various positions. No end play in this part would indicate that the left ends of the variable line space clutch dog cams 2-45069 are limiting on right end of variable line space plunger 2-43356 which would not permit the variable line space clutch dog cams 2-45069 to force the variable line space clutch dogs 2-45093 into the ratchet teeth securely, which is necessary to obtain even spacing between lines.

REMOVING CARRIAGE COMPLETE--METHOD #1 - Remove rear panel 2-41089. Unhook carriage tape 2-42033 by loosening its screw 2-40267 and attach to carriage tape screw 2-40119 in machine frame. Take out upper margin stop rack pull link screw 2-40177 and nut 2-40408 (margin release illustration). *Note: When it is known that carriage only is to be removed, always take out the upper margin stop rack pull link 2-40177 and nut 2-40408, as this makes it unnecessary to adjust the eccentric screw 2-42714 at the lower end of the margin stop rack pull link 2-45831.*

CAUTION: Make a mark (pencil mark will do) on the typewriter frame at the bottom of the front carriage rail on each side. The purpose of this mark is to facilitate the relocating of carriage to its proper position, which is determined by cylinder and anvil position.

Move carriage to the right, take out screw 2-40043 holding the adjusting



PLATEN & LINE SPACE MECHANISM

eccentric 2-44516 and carriage rail to the left side of the typewriter frame; also remove carriage rail mounting screw 2-40155. Move carriage to the left and repeat this operation on the right side of carriage rail. Lift the carriage complete, as a unit from the machine. Note if there are any shims between bottom of carriage rails and top of typewriter frame.

Remove carriage from carriage rails as follows: Take off tabulator stop set arm bracket 2-45475 (tabulator illustration) by removing two screws 2-40159. Take out the two carriage end stop screws 2-40290 and slide the carriage complete out of the carriage rails to the right. Remove one margin stop rack support pivot screw 2-40259 and nut 2-40465 (margin release illustration) and remove margin stop rack 2-46107.

Replace carriage to carriage rails as follows: From the right side, slide carriage into central position on rails (carriage trucks 2-45371 out). Put in both carriage end stop screws 2-40290. With the carriage set at the extreme left side, *with right carriage end casting limiting against its stop screw 2-40290,* insert the lower front carriage truck 2-45371 from left end of carriage and see that the roll on left end of truck is just inside of carriage rails. Next, with upper carriage truck rack screws 2-40185 loose, insert the upper rear carriage truck to its position. *Without moving the carriage,* look at both (right and left) ends of carriage truck rolls to see that they are within the carriage rails, if so, tighten screws in carriage truck rack 2-45420.

Note: It has been customary to move the carriage from one end of the writing line to the other and observe if the carriage trucks are centrally located. However, it does not apply to the Model 17 carriage. Replace the tabulator stop set arm bracket 2-45475 (tabulator illustration). The holes of this bracket are elongated; its location cannot be determined at this time.

Attach the carriage with carriage rails to the machine; set the carriage rails to the pencil mark previously made and put in the two carriage rear mounting screws 2-40155, holding carriage rails to the typewriter frame. Drop the carriage rail eccentrics 2-44516 in their slots of carriage rails, turn these eccentrics until the screw hole in base lines with the hole in the eccentric and put screws 2-40043043 in these eccentrics to hold them in place.

The correct location of the carriage can be determined as follows: In making this test have one sheet of paper in the carriage, press down firmly on the key lever, placing strip of paper between the type bar and anvil and note the pressure of type bar holding strip of paper. Release the type bar and place strip of paper between the ribbon and paper in carriage, then depress the key lever firmly and note the amount of bite or hold that the face of type has at this point. *There should be an equal bite or hold at both the cylinder and anvil positions.* If there is bite at the cylinder and none at the anvil it indicates that the carriage is too far forward. Loosen the carriage rear mounting screws 2-40155 and also the carriage rail eccentric screws 2-40043 and adjust the eccentrics 2-44516 until the carriage does have cylinder and anvil position, as described. Adjust both sides of the carriage to the front or rewr simultaneously, keeping the carriage rails parallel with the type bar segment.

CAUTION: If the machine is to do neat work it is imperative that the cylinder and anvil position is adjusted correctly. If the carriage is located too far to the rear it will result in light print work and poor carbon copies, if the carriage is too far to the front the result will be blurred print work.

After the carriage has been properly located for cylinder and anvil position, replace the margin stop rack 2-46107, pivot screw 2-40259 and nut 2-40465, margin stop rack to be free on pivot screws with no end play, replace the upper margin stop rack link screw 2-40177 and nut 2-40408. (Margin Release Illustration)

Have carriage centrally located and hold forward on paper table, and while in this position depress the set key and look down in front of the margin stop lever bracket 2-45848, (margin release illustration) and observe whether lip "A" of the tabulator stop set arm bracket 2-45475 is striking centrally on tabulator stops 2-47500 (tabulator illustration). If not, the tabulator stop set arm bracked can be moved to the right or left, since the holes for the bracket mounting screws are elongated. Be sure the tabulator stop set arm bracket screws 2-40159 are tight after adjustment is made.

If the carriage has play between the carriage rails this condition can be corrected by loosening the four upper rear carriage rail screws 2-40250. The holes for these screws are oversized and rear carriage rail 2-45379 may be moved toward the front rail until the play is removed, the screws 2-40250 can then be tightened. After adjusting the rear carriage rail 2-45379 to remove play, see that the carriage runs free ful length of writing line without play or binds. *NOTE: If the rear carriage rail was loosened up very much the carriage trucks 2-45371 may be out of position. To test, move carriage to the left until the right carriage end casting limits against the carriage end stop screw 2-40290 and while in this position look at both the right and left ends of the carriage trucks 2-45371 to see that both ends are inside carriage rails.*

REMOVING TABULATOR STOPS AND TABULATOR STOP RACK - By having the carriage to the right or left side, the tabulator stops 2-47500 (tabulator illustration) can be removed or replaced from the bottom of tabulator stop rack 2-47631, except a few in center of rack. The tabulator stop rack 2-47631 can be removed from carriage as follows: First depress clear key and restore all tabulator stops 2-47500, then take out the right tabulator stop rack screw 2-40016 and washer 2-40935. Move carriage to left as far as it will go and remove the left tabulator stop rack screw 2-40016 and washer 2-40935 -- lower left end of tabulator stop rack clear of left carriage end casting and take out.

Reverse the procedure in replacing tabulator stop rack 2-47631, making sure that right end is against the tabulator stop rack adjusting screw 2-40088 -- for adjustment of this screw refer to tabulator instructiins.

PLATEN - Release the right platen lock 2-45368 and left platen lock 2-45467 and lift platen complete 2-43646 out of carriage.

Remove paper trough 2-45639 by lifting its studs clear of the paper trough support brackets.

Lift out rear paper feed roll 2-46483 and front paper feed roll 2-46482.

Remove paper feed roll release shaft 2-45211 by loosening set screw 2-40110 in collar 2-40911 and remove collar. Have feed roll release lever 2-45200 in released position and pull feed roll release shaft 2-45211 out to the right. Replace this shaft and hold in position by its collar 2-40911. Make sure feed roll release lever link is over stud in feed roll release shaft 2-45211.

Take off the margin stop lever bracket 2-45848 (margin release illustration) by taking out the margin stop lever bracket screw (right) 2-40175 and margin stop

lever spring screw (left) 2-40261. Do not lose the margin stop lever return spring 2-40398.

REMOVING AND REPLACING OF PAPER TABLE COMPLETE - With paper feed roll release lever 2-45200 forward and right carriage release lever depressed, take out the upper right paper table support screw 2-40079. Lift up on right paper table support 2-45560 and remove paper table complete with springs attached. Do not lose end play washers 2-40936 (if any) on the paper table pivot bearings.

After replacing paper table, place loose ends of paper table springs in back of the lip on upper ends of the right and left paper table supports. Make sure that screws 2-40137, holding left paper table support 2-45559, are tight -- when writing on machine check all points of paper table for noise.

REMOVE PAPER SCALE (BAIL) - Remove four screws 2-40170, two in each of the right and left paper scale arm shaft brackets (right 2-46265 and left 2-46264). Remove these brackets. Remove both paper scale arm springs 2-40371. Take out paper scale arm detent screw 2-40285. Remove the right carriage scale screw 2-40280 and work the paper scale arm shaft assembled 2-46266 upward and out of carriage. (Note both screws could be removed from the carriage scale but this would make it necessary to readjust it). Replace the paper scale (bail) by reversing these instructions. Paper fingers may be put on in place of bail when requested. Paper fingers and bail both cannot be used.

Replace front paper feed roll 2-46482.

Replace rear paper feed roll 2-46483.

Make sure that feed rolls turn freely on shaft.

Replace the paper trough 2-45639.

CARRIAGE REMOVAL--METHOD #2 - Remove rear panel 2-41089. Unhook carriage tape 2-42033 and hook it to carriage tape screw 2-40119. Loosen left margin stop rack pivot screw nut 2-40465 and take out margin stop rack pivot screw 2-40259. Drop margin stop rack 2-46107 back out of the way. Remove the two carriage end stop screws 2-40290 and also remove rear carriage rail 2-45379 by taking out the four carriage rail screws 2-40250. Slide carriage to left end of writing line (viewed from rear) and remove carriage from carriage bed rails, being careful not to bend lip "A" of the tabulator stop set bracket 2-45475.

TO REPLACE CARRIAGE - With carriage roll retainers 2-45371 out of rails, set the carriage into rails, making sure that lip "A" on the stop set arm bracket 2-45475 (tabulator illustration) is directly over tabulator stops 2-47500 on stop rack and that carriage front rail is positioned under the lower carriage rail cover 2-45433.

Replace upper carriage rail, leaving the four carriage rail screws 2-40250 loose, and place end stop screws 2-40290 in their positions.

Move carriage to extreme right (viewed from rear) until right carriage end casting limits against carriage end stop screw 2-40290, and insert front carriage roll retainer 2-45371 between carriage rails until both ends of carriage roll retainer are inside rails. Before replacing rear upper carriage roll retainer, loosen the screws 2-40185 in carriage roll retainer rack 2-45348. Replace upper carriage roll retainer 2-45371 with both ends inside of carriage rail.

Tighten the carriage roll retainer rack screws 2-40185.

Set carriage with right carriage end casting limiting against stop screw 2-40290. With light pressure downward on left end of rear carriage rail 2-45379, tighten left carriage rail screw 2-40250.

Set carriage with left carriage end casting limiting against its stop screw 2-40290. With light pressure downward on right end of rear carriage rail 2-45379 tighten right carriage rail screw 2-40250. Carriage still in this position, use light pressure downward on center of rear carriage rail 2-45379 and tighten the two center rear carriage rail mounting screws 2-40250.

Test carriage for free full length of writing wine with no play or binds allowed. When in doubt about free running carriage remove escapement complete and test.

Replace margin stop rack 2-47107 pivot screw 2-40259 and lock nut 2-40465. No end play aloowed in margin stop rack but must be free to pivot on screws 2-40259. Hook up carriage tape 2-42033. Replace rear panel 2-41089.

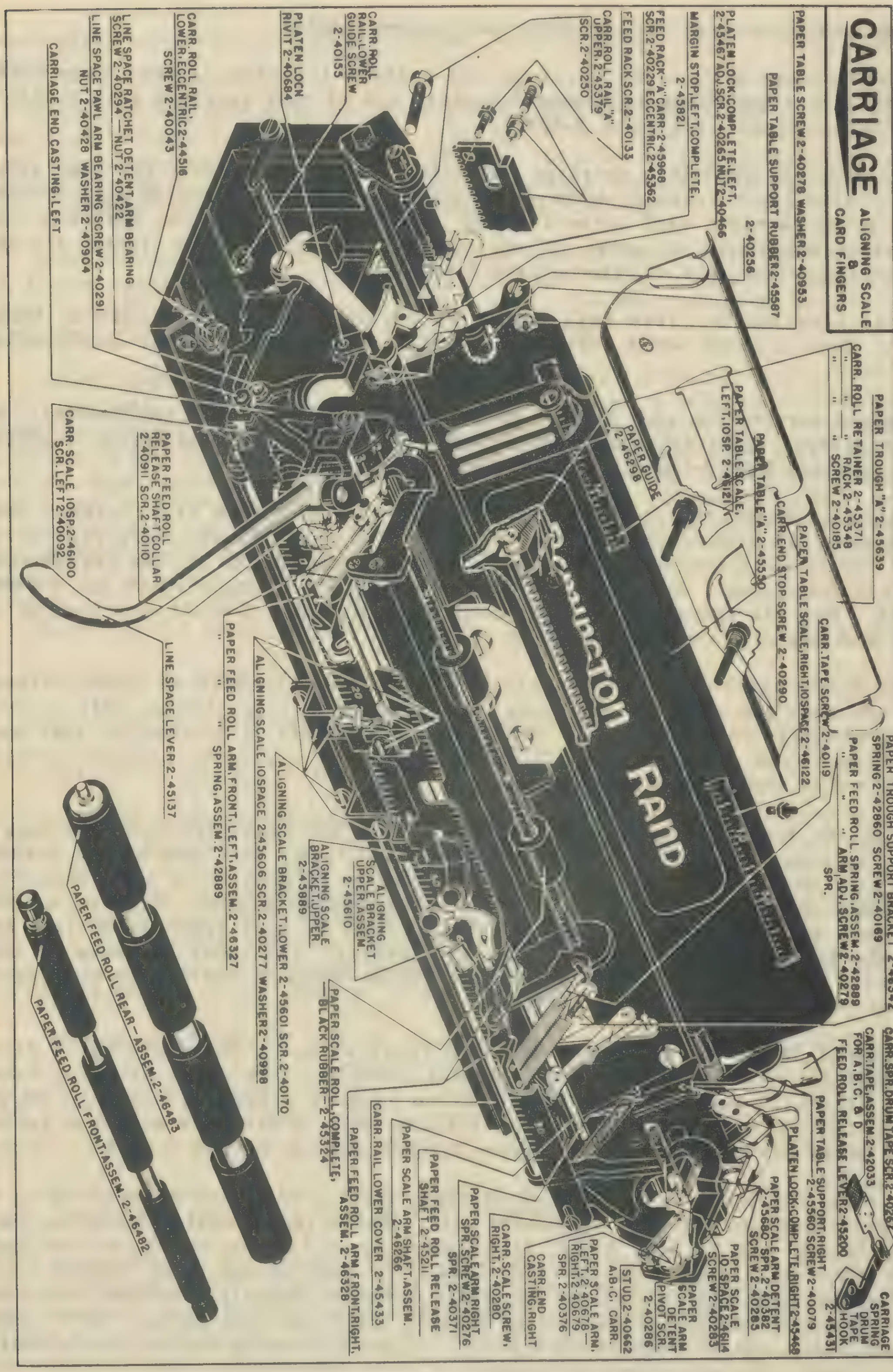
Replace platen complete 2-43646 and hold in place with right platen lock 2-45468 and left platen lock 2-45467. *NOTE: The platen lock adjusting screws 2-40265 should be adjusted so there is a slight detent action as the platen lock lever is pressed down. Make sure that the platen lock adjusting screw nut 2-40466 is tight. Use oil sparingly on the platen roll bushings 2-40985 and 2-40986 to prevent bushings from freezing to platen shaft.*

Check the paper feed roll tension by placing small strip of paper between platen and each end of feed roll (rear) and without turning platen, pull it out. The tension should be even--if not, adjusing screw 2-40279 is provided at rear ends of each paper feed roll arm spring 2-42889--turn in on screws to increase tension and back out on them to decrease tension.

Carriage feed rack 2-45958 is adjustable, up and down only (not sideways). Move carriage to the right (end of writing line) and loosen feed rack screws 2-40133 holding left end if feed rack and adjust feed rack up or down for a small amount of play between the teeth of feed rack and escapement wheel pinion. Tighten the two screws when adjustment is made. Move carriage over to left (end of writing) and repeat the same adjustments on left side of carriage. Care must be taken in this adjustment, if feed rack is set too deep in pinion wheel it will cause a sluggish operating carriage and piling of letters.

ALIGNING SCALE AND CARD FINGERS - The lower aligning scale bracket 2-45601 is mounted to the carriage rail with screws 2-40170. The upper aligning scale bracket assembled 2-45610 (with card tension fingers attached) are held to the lower bracket by screws 2-40170. The aligning scale 2-45606 is attached to the upper aligning scale bracket by two screws 2-40277 and two washers 2-40998.

To align the scale to the line of writing, write a full line of small (i's) on the paper across the width of the platen roll. The aligning scale should be level with the line of writing just a very fine line or space between the top of the scale 2-45606 and the bottom of the written line. If high on one side, loosen screw 2-40277 on the high side and adjust the scale downward slightly. If low, raise the scale in the same manner. This applies to both right and left sides. *NOTE: Some side adjustment can be made at this point, if both mounting screws for aligning scale is loose. See adjustment following.*


CARRIAGE
ALIGNING SCALE & CARD FINGERS
PAPER TROUGH "A" 2-45639
CARR. ROLL RETAINER 2-45371
" " " RACK 2-45348
" " " SCREW 2-40185
PAPER TROUGH SUPPORT BRACKET 2-46342
SPRING 2-42860 SCREW 2-40169
PAPER FEED ROLL SPRING, ASSEM. 2-42889
" " " ARM ADJ. SCREW 2-40279
SPR.
CARR. SPR. DRUM TAPE SCR. 2-40267
CARR. TAPE, ASSEM. 2-42033
FOR A, B, C, & D
FEED ROLL RELEASE LEVER 2-45200
CARRIAGE SPRING DRUM TAPE HOOK
2-45431
PAPER TABLE SCREW 2-40278 WASHER 2-40953
CARR. TAPE SCREW 2-40119
PAPER TABLE SCALE, RIGHT, 10 SPACE 2-46122
PAPER TABLE SUPPORT, RIGHT
2-45560 SCREW 2-40079
PLATEN LOCK, COMPLETE, RIGHT 2-45468
PAPER TABLE SUPPORT RUBBER 2-45587
CARR. END STOP SCREW 2-40290
PAPER TABLE "A" 2-45530
PAPER SCALE ARM DETENT
2-45680- SPR. 2-40382
SCREW 2-40285
2-40256
PAPER TABLE SCALE, LEFT, 10 SP. 2-46121
PLATEN LOCK, COMPLETE, LEFT,
2-45467 ADJ. SCR. 2-40265 NUT 2-40466
PAPER SCALE 10-SPACE 2-46114
SCREW 2-40283
MARGIN STOP, LEFT, COMPLETE,
2-45821
PAPER SCALE ARM DETENT PIVOT SCR.
2-40286
FEED RACK-"A" CARR-2-45968
SCR. 2-40229 ECCENTRIC 2-45362
PAPER GUIDE
2-46298
FEED RACK SCR. 2-40133
STUD 2-40662
A, B, C. CARR.
CARR. ROLL RAIL "A"
UPPER, 2-45379
SCR. 2-40250
PAPER SCALE ARM,
LEFT, 2-40678-
RIGHT, 2-40679
SPR. 2-40376
CARR. END
CASTING, RIGHT
CARR. SCALE SCREW,
RIGHT, 2-40280
PAPER SCALE ARM RIGHT
SPR. SCREW 2-40276
SPR. 2-40371
PAPER FEED ROLL RELEASE
SHAFT 2-45211
PAPER SCALE ARM SHAFT, ASSEM.
2-46266
ALIGNING SCALE BRACKET UPPER, ASSEM.
2-45610
CARR. RAIL LOWER COVER 2-45433
CARR. ROLL RAIL, LOWER GUIDE SCREW
2-40155
PAPER FEED ROLL ARM FRONT, RIGHT,
ASSEM. 2-46328
PAPER SCALE ROLL, COMPLETE,
—BLACK RUBBER—2-45324
ALIGNING SCALE BRACKET, UPPER
2-45889
PLATEN LOCK RIVIT 2-40684
ALIGNING SCALE BRACKET, LOWER 2-45601 SCR. 2-40170
ALIGNING SCALE 10SPACE 2-45606 SCR. 2-40277 WASHER 2-40998
PAPER FEED ROLL ARM, FRONT, LEFT, ASSEM. 2-46327
" " " SPRING, ASSEM. 2-42889
CARR. ROLL RAIL,
LOWER, ECCENTRIC 2-44516
SCREW 2-40043
PAPER FEED ROLL
RELEASE SHAFT COLLAR
2-40911 SCR. 2-40110
LINE SPACE LEVER 2-45137
PAPER FEED ROLL REAR—ASSEM. 2-46483
LINE SPACE RATCHET DETENT ARM BEARING
SCREW 2-40294 — NUT 2-40422
LINE SPACE PAWL ARM BEARING SCREW 2-40291
NUT 2-40428 WASHER 2-40904
PAPER FEED ROLL FRONT, ASSEM. 2-46482
CARR. SCALE 10SP. 2-46100
SCR. LEFT 2-40092
CARRIAGE END CASTING, LEFT

The white lines on the scale should be in line with the vertical lines of the letter (i). The side alignment of the scale is obtained by loosening the two screws holding the upper aligning scale bracket 2-45610 to the lower aligning scale bracket 2-45601. The upper holes in the lower aligning scale bracket are elongated and after the screws are loosened the upper scale bracket along with the aligning scale, may be moved to the right or left to get the desired result.

The aligning scale should be just far enough away from the platen that six sheets of paper can be inserted between the aligning scale and platen, and also card tension fingers when up. To obtain this condition, form the upper aligning scale bracket 2-40998. After making this adjustment check the right carriage scale screw 2-40280, to see that it does not interfere with the rear side of the upper aligning scale bracket as it passes bracket.

ADJUSTMENT CARRIAGE SCALES, PAPER SCALE AND PAPER TABLE SCALE - Adjusting of carriage scales should not be attempted until all adjustments pertaining to escapement and carriage feed rack have been made.

Set carriage until cipher on carriage scale 2-46100 is in line with indicator on type guide, if cipher does not align perfectly, loosen screws in ends of carriage scale 2-46100 and adjust scale.

Adjust the margin stop rack pivot screws 2-40259 until margin stop rack 2-46107 is centrally located between margin stop rack supports, with very slight amount of end play, yet free on its pivot screws.

Set margin stop 2-45823 at cipher position on margin stop rack 2-46107, return carriage to right until margin stop lever limits against margin stop 2-45823.

The margin stop lever should clear the margin stop at this point .060" (use .060" noiseless gage). Adjust for this clearance by margin stop rack pivot screws 2-40259. *NOTE: This clearance is necessary, otherwise operator could not back space into first space of left margin.* Another test for this is: Set carriage at zero, margin stop at zero, strike space bar once, hold back space key lever all the way down and strike margin release lever several times slowly and note whether margin stop binds against margin stop lever, should just clear. Margin stop rack 2-46107 must be set as described, otherwise irregular margins will result.

Slide paper guide 2-46298 to left as far as it will go. Place sheet of paper in carriage and have left edge of paper in line with the cipher mark on carriage scale 2-46100. *NOTE: The edge of paper will also align with cipher on the paper scale 2-46114, if not, this scale should be set accordingly.* With sheet of paper still set in carriage at the cipher position, slide the paper guide 2-46298 to left edge of paper. At this point, note where pointer on paper guide is pointing to on paper table scale, left 2-46121. It should be pointing at cipher also, if not, loosen screw 2-40278 holding left end of paper table scale and slide it until cipher is in line with pointer on paper guide.

The setting of right paper table scale 2-46122 is: Insert sheet if paper in carriage, having right side of it in line with 80 on both the carriage scale 2-46100 and the paper scale 2-46114. Loosen screw 2-40278 in right end of right paper table scale 2-46122 and set point of 80 scale in line with right edge of paper. This scale is to assist operator in locating center of sheet when making headings, etc.

DISMANTLING PROCEDURE FOR CLEANING AND OVERHAULING - Remove carriage, method #2 recommended, remove rubber. Remove typewriter unit complete. Remove ribbon winding disc 2-42346 and ribbon.

Remove lever knobs 2-42289, panel screws 2-40222 and take off front panel 2-46861 (type action illustration). Do not lose rubber silencer washer 2-40892 between front panel and typewriter frames.

Remove two type bar fulcrum wire retaining screws. Remove type bar fulcrum wire slowly and keep type bar links in order, as explained in instructions.

NOTE: Order Type bar links 2-41410, which are straight, these can be formed to suit the position in which they are to be used, 2-41432 is the number for type bar twenty-one and twenty-two which are ground for clearance.

Remove two screws 2-40244 holding type bar cushion 2-43943 to segment and remove type bar cushion complete. Remove four screws 2-40111 holding ribbon actuator arm bracket support 2-41954 (ribbon cover illustration) to machine.

Unhook lower end of ribbon lift push link 2-42284 from toggle bell crank (ribbon cover illustration). Unhook spring clip at rear end if ribbon control lever link 2-46568 from the ribbon control shaft arm 2-42342.

Lift the ribbon actuator arm bracket support complete with ribbon control shaft, ribbon lift push link and ribbon carrier, from machine.

Remove screw 2-40000 and nut 2-40411 (shift mechanism illustration), holding left end of segment to segment shift rocker. Repeat this operation on the right side.

Unhook the two segment shift balance springs 2-40364 (shift mechanism illustration) at upper ends.

Remove two segment shift bracket screws 2-40188, holding bracket to segment. Remove type bar segment 2-47050 complete with type bar universal bar assembled. Do not lose the segment ball bearings 2-40477 when removing segment. Use care in handling the type bar segment, as universal bar adjustments may be thrown out.

After machine has been washed, reassemble by reversing these instructions.

NOTE: AA key lever can be removed from the machine as follows: Unhook type bar bell crank link from stud in key lever, unhook key lever spring (upper end). Loosen screws in key lever clamp, holding rear end of key levers in position. Slide rear end of key lever downward until it clears its fulcrum wire 2-41103 (type action illustration) and remove key lever.

A type bar bell crank can be removed as follows: Unhook type bar bell crank link from stud on key leverl Unhook upper end of type bar bell crank spring 2-40338 (upper end). Loosen the five screws for type bar bell crank fulcrum wire clamp and use follow up wire to the bell crank that is to be taken out.

INSPECTIONS

CARRIAGE

Carriage, free full length of writing line with no play in rails.
Platen for condition and end play.
Test front and rear feed rolls for pressure (both ends) and condition.
Try line space mechanism for underthrow or overthrow of plates.
Test one, two and three line spacing and platen detent for proper tension.
Test both variables, platen locks and paper release.

Paper bail functioning properly.
Line gage for height and clear platen (six sheets), also try card finger attachment.
Paper guide to stay into position, where set.
See that carriage roll retaining racks will not permit carriage roll retainers to creep.
Carriage feed racks set to escapement wheel pinion correctly.
Carriage release levers functioning properly.
Correct carriage tension.

TYPEWRITER UNIT

SEGMENT

Hold shift key down, test capital letters for on feet, segment to be locked with no vertical play.
Test motion HhHhHh. No vertical play in segment when normal. Segment to be locked in both upper and lower cases. No bite or binding in shift keys at top or bottom of travel.
Segment to shift freely, no horizontal play allowed.
Shift keys set to correct height, shift lock plates (two) set correct.
Test machine for cylinder and anvil position.

TABULATOR

Test tabulator blade, clear key and set key for proper travel.
Test tabulator drop, approximately a full space. Test tabulator blade for entering between two stops.
Tabulator set bracket for correct position.
Try tabulator brake for short and long jumps.
Tabulator rack and front carriage scale to agree.

RIBBON MECHANISM

Strike off keyboard of both upper and lower case on both black and red ribbon, test ribbon for cover, also stencil position.
Test ribbon for reversing at both ends, right and left spools.
Set ribbon drive shaft shift lever to central position and try winding spools.

ESCAPEMENT MECHANISM

Test trip at ribbon on type bars one, twenty-one and forty-two.
Test escapement safety zone 1/2" to 9/16"
Inspect loose dog silencer mechanism.
Check position of upper and lower escapement rocker body stop screws.

MISCELLANEOUS

Try touch regulator, type bar restoring feature and back spacer.
Test margin release, line lock and bell mechanism.
Check space bar adjustments, height, depth and trip.
Inspect machine in general for appearance of nickel, japanning, stencils, etc.
Try machine for alighment of both upper and lower cases.
Keyboard, numerals, type spacing and carriage width to agree with machine order.

CHAPTER IX

TYPEWRITERS

SECTION 2

- ROYAL -

RING AND CYLINDER ADJUSTMENT

UPPER SHIFT STOPS - The upper shift stops (6) are designed to arrest the downward movement of the segment so that when accurately positioned, the center line of the type face will coincide with the dead center line of the cylinder, thereby maintaining the curvature of the type face in proper relation to the cylinder radius. If upper shift stops are positioned too high or too low, the type impression will either show light on the bottom or top. Under no circumstances should upper shift stops be employed to correct faulty motion, as this will impair the relation of the type face to the cylinder.

LOWER SHIFT STOPS - The lower shift stops (7) are identical in design with the upper shift stops (6) and are adapted to control the motion or vertical alignment of the upper and lower case characters. These stops (7) can be adjusted until perfect motion is attained. The distance between the lower edge of upper and lower case characters, or what is termed the motion, is on standard equipment .265 (two hundred and sixty five thousandths of an inch). The distance between the lower shift stops and lower shift stop cushions (8) should approximate this distance when the shift key is depressed. All four abutting surfaces of the shift stops should be tested with a thin piece of paper, to check that equal contact is being made with the shift stop cushions.

Shift frame extension (9) serves to limit the stroke of the shift key levers and should be adjusted to allow 1/16" additional depression of the shift key after the upper shift stops (6) have contacted the cushions (8). (See dash-dotted lines in cut.) This provides motion for the release of the shift lock arm (15).

TYPE BAR TRIP - The type bar trip should be set so that type bars will trip the escapement when type face is approximately 3/8" from the cylinder. It is recommended that they be tested by bringing the bar up to the tripping point with the finger as a more accurate setting can be obtained than by testing with key lever. Universal trip adjustment is provided by turning trip adjusting screw (17) clockwise to set the trip farther out from cylinder and counterclockwise to set trip closer to cylinder. Individual adjustment is provided by bending universal bar links (18) at point shown on cut. Be sure to tighten lock nut on trip adjusting screw (17).

UNIVERSAL BAR RIBBON ADJUSTING SCREW - If with the trip properly set and type face held against cylinder, vibrator arm fails to contact cam solidly, it will indicate that ribbon adjusting screw will have to be reset, so that all play will be removed from ribbon vibrator when type face is held against the cylinder. Failure to make proper adjustment will prevent the ribbon from raising to its proper height, will cause tops of characters to miss the ribbon.

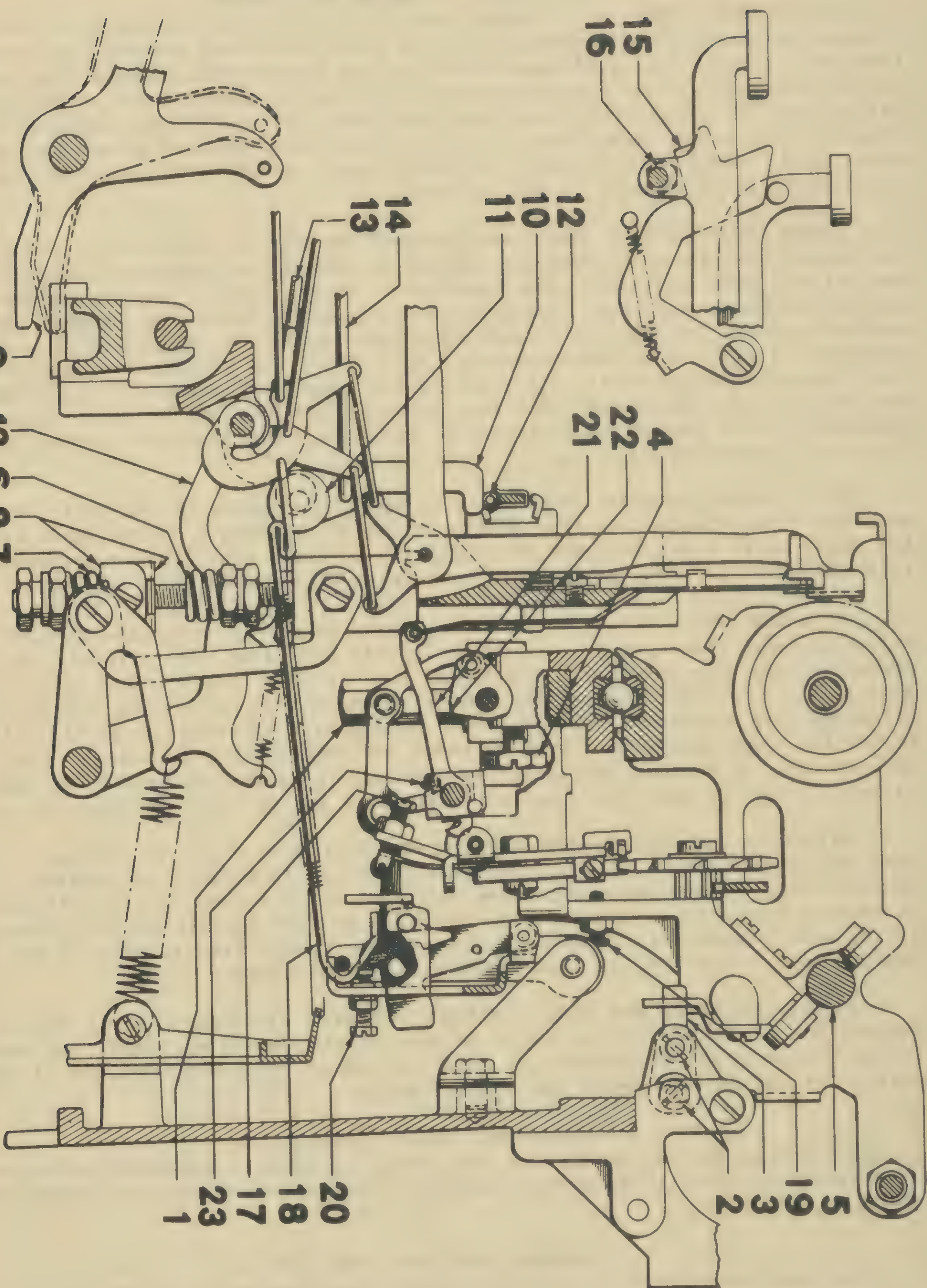
RIBBON VIBRATOR ARM STOP - Ribbon vibrator arm stop (23) is designed to control the set of the ribbon and in no way affects the ribbon throw, and should be set so that with ribbon vibrator at rest, the top of the ribbon will set at approximately 1/16 of an inch below top of card scale.

REMOVING SPRING BARREL

Main Spring Tension should not be in excess of what is necessary to insure positive travel of carriage to extreme left with relation to Escapement, Tabulator and Line Lock.

CARRIAGE RACK AND RACK BAIL

Carriage Rack #1 must be adjusted so that positive mesh with Escapement Pinion #2 is maintained. Depth of Rack #1 in Pinion #2 is controlled by Rack Bail Eccentric Stop Screws #3 (Right and left) and should be adjusted so that they will permit Carriage Rack #1 to engage teeth in Pinion deep enough to insure positive meshing.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2

If rack teeth mesh too deeply, it will cause excessive wear and interfere with operation of carriage and will also cause a harsh noise when carriage is returned.

Eccentric Stop Screws Right and Left #4 are designed to control the height of the Carriage Rack #1 when released from Pinion #2 and should be set so that rack will clear pinion not exceeding 1/16". If position of Rack and Pinion has been changed, it will be necessary to check Rack Release Levers #5 to see that Rack Bail Eccentric Stop Screws #3 are not preventing Rack from setting proper depth in Pinion. Before attempting to lower Rack, turn Eccentric #3 to a lower point and readjust so that there is a little play between Rack Release Levers #5 and Eccentric Stop Screws #3. If Rack is set too deeply in Pinion, it will be necessary to set Eccentrics #3 to a higher position. After change has been made, be careful to note that there is a little play in Rack Release Levers #5.

ESCAPEMENT

Escapement Wheel Check Pawl #20 must be free on its bearing, and Check Pawl Spring #21 must have the necessary tension to return the Check Pawl to inactive position. Escapement Wheel Check Pawls are numbered to correspond with carriage spacing and are not interchangeable in all cases. For 6, 12 and 14 pitch, Check Pawls are numbered 1. For 5 and 10 pitch Check Pawls are numbered 2. For 9 and 16 pitch, Check Pawls are numbered 3. For 8 pitch, Check Pawls are numbered 4. It is imperative that the proper Check Pawl be installed. Escapement Wheel Check Pawls are not used on 20 pitch machines.

SPACE BAR

Space Bar #11 must operate freely in Key Lever Bracket #1. Space Bar Spring #2 must have sufficient tension to return Space Bar to inactive position.

RIBBON FEED

See that all Set Screws #1 shown on cut are secure and that Ribbon Beveled Gears Nos. 2 and 3 are properly meshed, that Idler Gear #4-A and Spur Gear #4 are in proper mesh, and that Ribbon Spool Shaft Spur Gear left #4 and Ribbon Spool Shaft Beveled Gear #3 are set so that they do not bind against bottom of Ribbon Spool Bracket and interfere with the free movement of Ribbon Spool Shafts #5. Adjustment of Ribbon Spool Tension Springs #6 is controlled by adjusting Tension Spring Collar #7. Care should be exercised not to put too much tension on Ribbon Spool Shafts #5 as this will retard the free travel of the ribbon feed. Sufficient tension to provide a slight drag on the ribbon to prevent a back lash in the Ribbon Spools is all that is necessary.

Note that Ribbon Vibrator #16 is properly formed and that sufficient clearance is provided at point #16-A. It is also necessary to see that the Ribbon Vibrator #16 does not hug Type Bar Guide #17 too tightly as this will cause the Ribbon Vibrator to stick. The Ribbon Vibrator should be adjusted so that it is flat against the back of the Type Bar Guide #17 without springing or binding against it. Note that Ribbon Vibrator Arm Spring #18 is properly connected and of sufficient tension to return vibrator to normal position. If Ribbon is lifting too high or not lifting high enough, bend the end of the Ribbon Vibrator Arm #19 up or down, using Benders #s-39.

LINE SPACE LEVER-FRACTIONAL LINE SPACE-LINE SPACE DETENT AND RELEASE

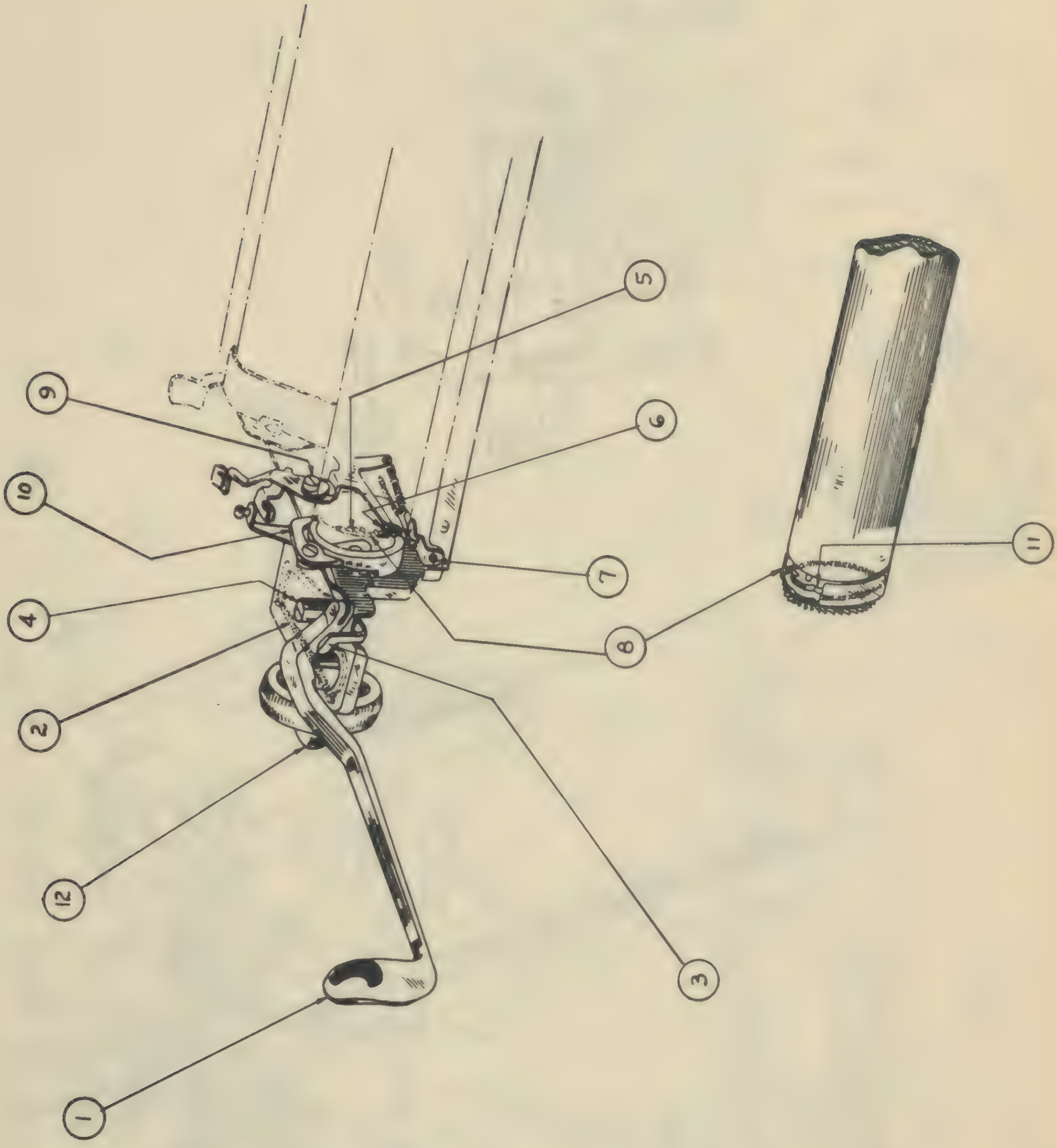
When Line Space Lever #1 contacts Line Space Lever Eccentric Stop Screw #4, Line Space Ratchet Tooth #5 should set securely in Line Space Detent Roll #6. If Eccentric Screw #4 is set so that it arrests Line Space Lever before Ratchet Tooth rests securely in Detent Roll #6, the cylinder will creep forward until ratchet tooth finds its normal position. This should not occur, and Eccentric Screw #4

should be set so that Line Space Ratchet Tooth #5 finds its set position in Line Space Detent Roll #6 at the instant Line Space Lever #1 contacts Line Space Lever Eccentric Stop Screw #4.

Should Line Space Lever Eccentric Stop Screw #4 be set so that the Ratchet Tooth #5 overthrows Line Space Detent Roll #6, difficulty with Line Spacing can be anticipated, therefore it is imperative that the proper relation of Line Space Lever, Line Space Ratchet and Line Space Lever Eccentric Stop be maintained.

REMOVING TYPE BARS

When substituting or replacing original Type Bars, it is found that the fit in the Segment Slot is too tight, it is recommended that segment bearing surfaces of Type Bars be rubbed on emery cloth and laid on a flat surface until free fit in segment slot is obtained.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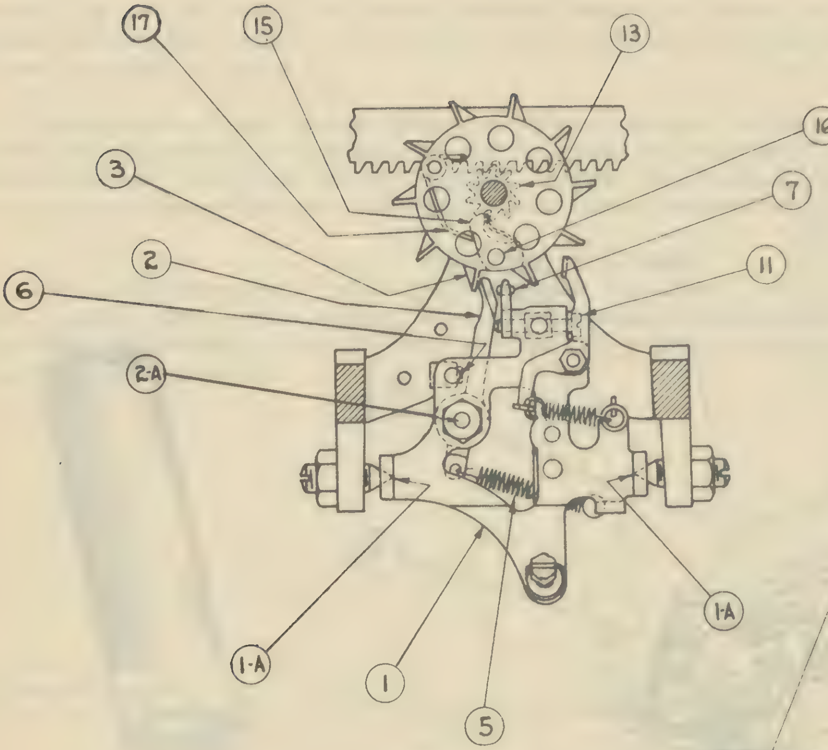
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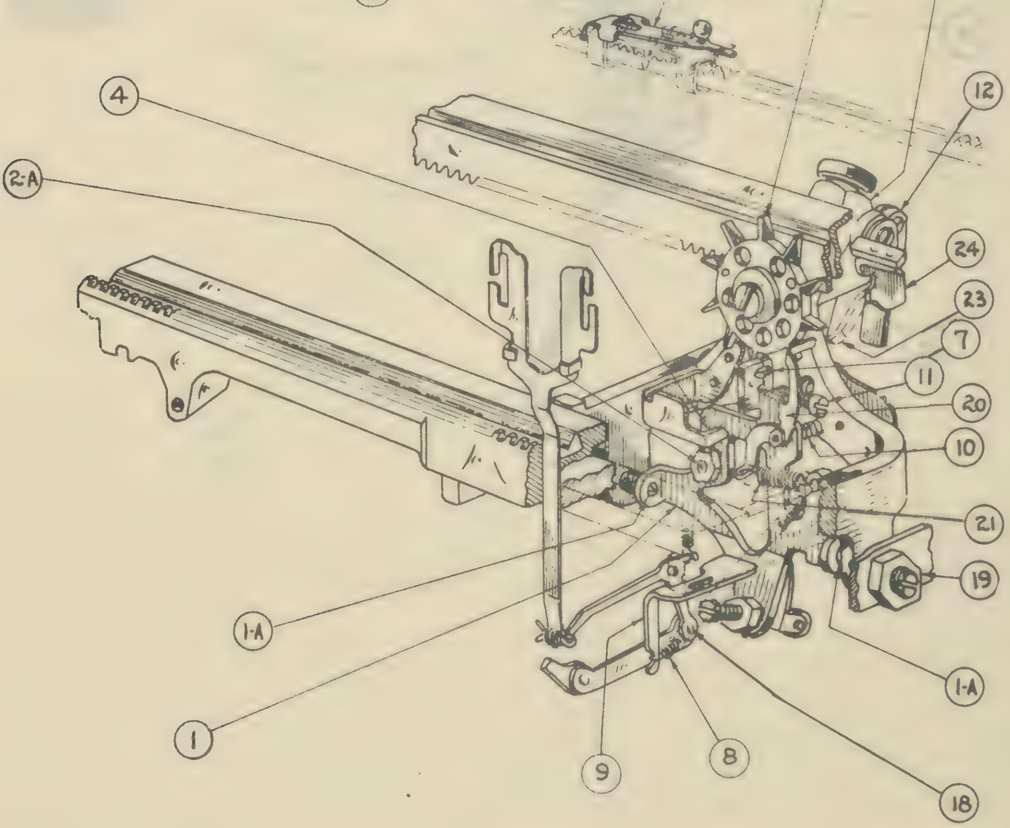
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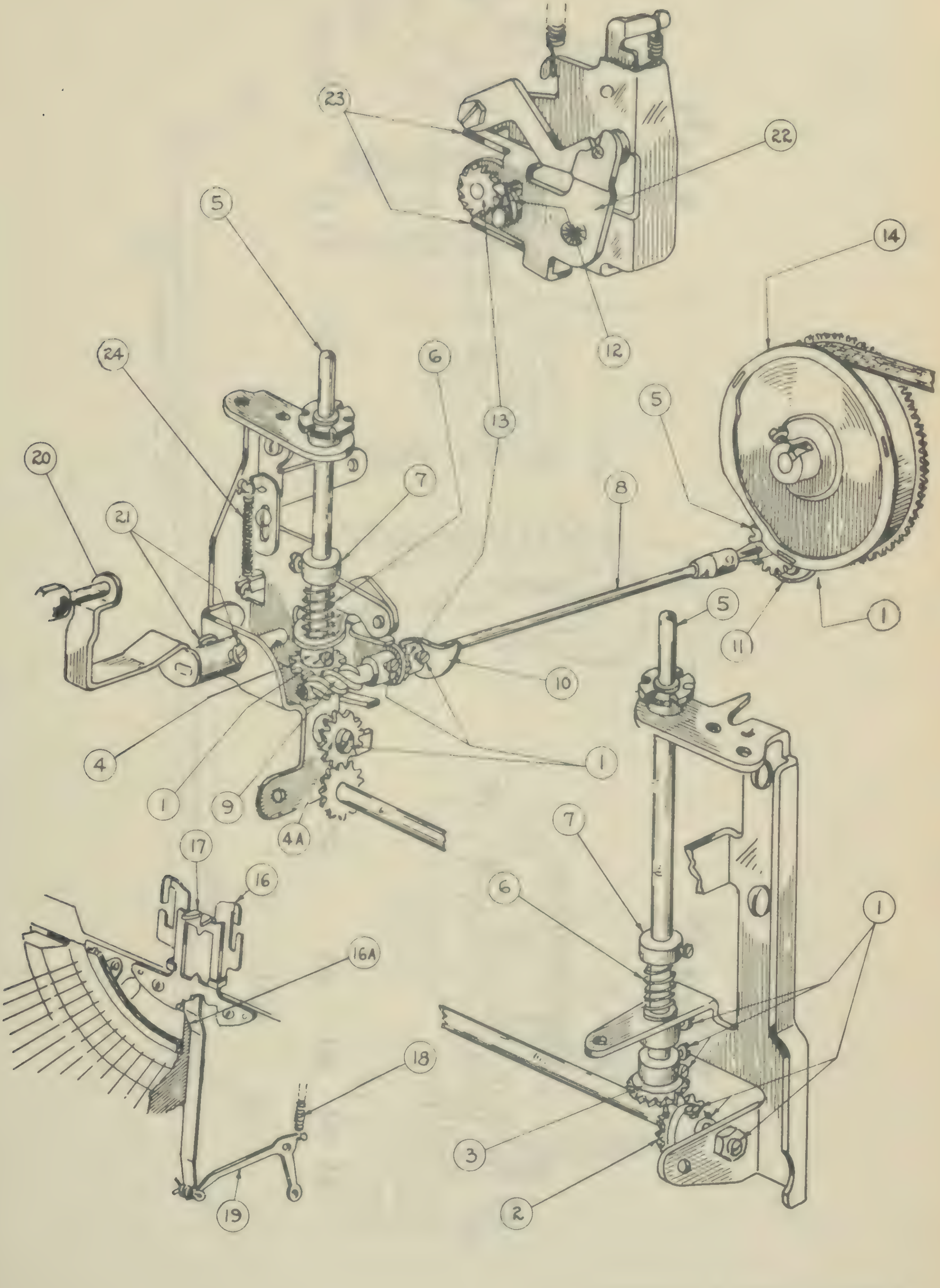
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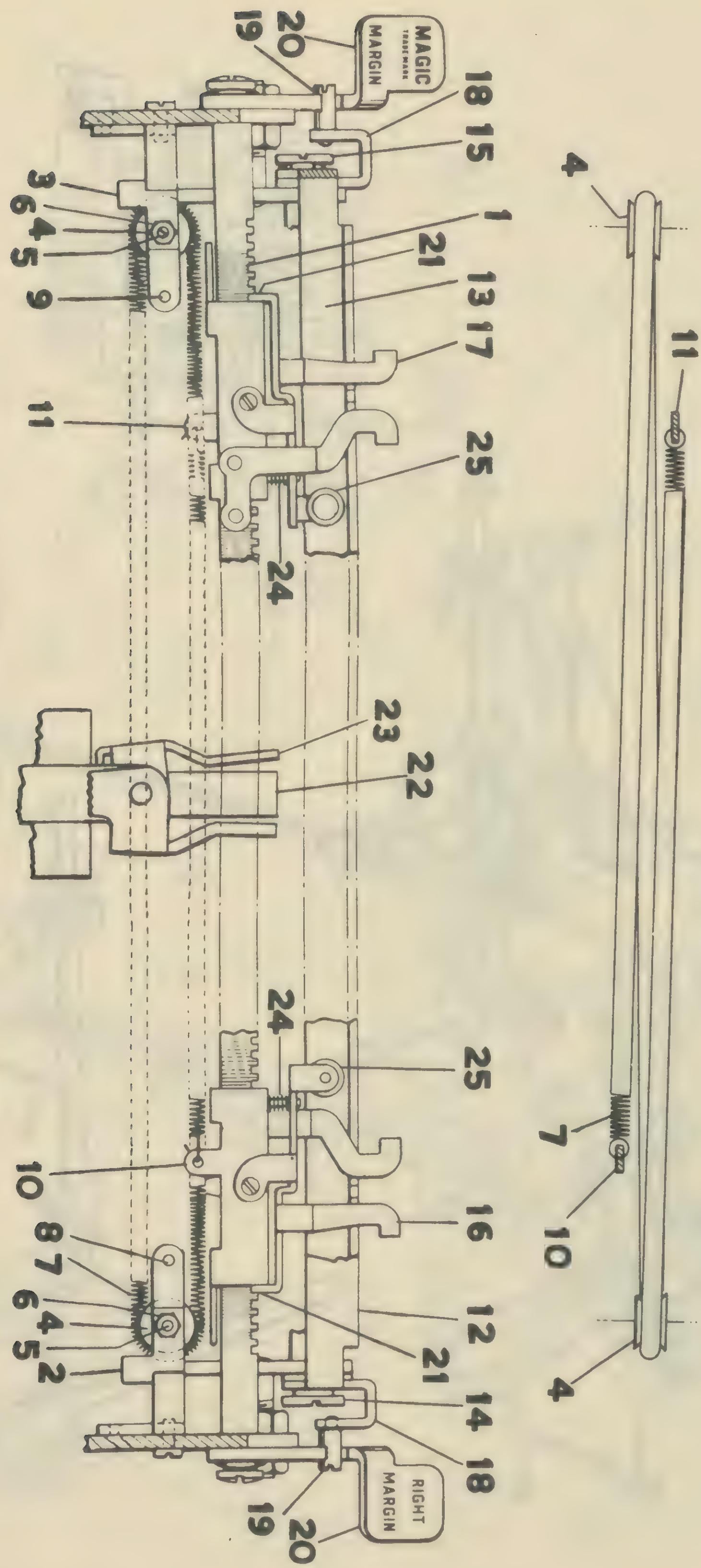
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CHAPTER IX

TYPEWRITERS

SECTION 3

- WOODSTOCK -

LINE LOCK AND RELEASE - Check Line Lock Bail MA-32 and see that it has a little side play and that there is no binding in the Line Lock Release Lever KB-107. If the Line Lock Trip C-641 (Illustration 4) on the right hand margin stop is positioned correctly, the line lock should come within 1/64" of key lever comb FA-329 when the line lock trip is riding on the Line Lock Lever MA-561 (Illustration 4). It must just clear the bottoms of the key levers and release easily when the Line Lock Release Lever KB-107 is pressed. Failure to release may be due to binding in the release lever mechanism (check this) or a broken Line Lock Release Spring K-112, or Line Lock Bail Spring.

CARRIAGE MOTION

ALL TYPE NOT PRINTING ON THEIR FEET - Remove carriage and plates. If type are not printing on their feet (too light on either the top or bottom) raise or lower, whichever may be necessary, the sub-carriage by loosening the upper shift adjusting screw nut C-418 (Illustration 5) and turning the adjusting screws C-416 on both ends of carriage, in or out until the type are printing evenly. See that the tension on both adjusting screws is even, which may be determined by placing a piece of thin cigarette paper between the Adjusting Screws and the Shift Stop Levers C-406 (Illustration 5) and pulling it out, the drag should be the same on either side.

CAPITAL LETTERS OUT OF MOTION WITH SMALL LETTERS - Use Lower Adjusting Screws C-417 exclusively for this purpose. If capital letters are LOWER than small letters, turn the lower adjusting screws C-417 CLOCKWISE. If capital letters are HIGHER than small letters, check your sub-carriage first to see that there is no obstruction holding sub-carriage from going its maximum travel upward. If no obstruction - then turn the Lower Adjusting Screws C-417, ANTI-CLOCKWISE, to bring them into position. Check motion with Capital H and small h. When adjustments are made, be sure to tighten Lock Nuts C-418.

(NOTE: Combination Socket wrench and Screw Driver 1316 - 1/4" hex. is best tool for use in setting motion).

LINE SPACE LEVER

If Line Space Lever LC-510 fails to space the platen, inspect the Line Space Pawl Spring L-18 for breakage; a new one may be installed by loosening Line Space Pawl Nut L-20, let the Pawl L-17 fall down past the stop and placing a new spring in the hole in top of the pawl, guide the pawl back into position and tighten up pawl nut. Make sure that all screws and nuts in the line space lever assembly are tight.

The correct throw of the Line Space Pawl is regulated by the Line Space Bracket Stop Screw L-505 and the Line Space Stop Screw L-26. To adjust, loosen the Lock Nut on these two screws and pressing the Line Space Lever to the right until the roller on the platen detent lever LA-330 engages between the platen ratchet teeth at the extreme end of the throw, then, holding the Line Space Lever in this position, turn the Line Space Stop Screw L-26 until it just touches the Pawl, then tighten the Lock Nut; the Line Space Bracket Stop Screw L-505 should then be turned in until it just touches the Line Space Lever and locked in place with Lock Nut 2024.

PAPER FEED

CAUSES FOR PAPER FEED TROUBLES - Check each of the following before attempting any adjustments. Feed roller bearings should be oiled sparingly. Platen and feed roller surfaces should be cleaned with alcohol.

1. No end shake in paper feed rollers.
2. Paper feed rollers bearings dry.
3. Paper feed rollers binding.
4. Paper finger or bail rollers binding.
5. Line finder tension too heavy.
6. Paper pan binding the paper.
7. Glossy platen and/or feed rollers.
8. Platen binding or too much end shake in platen.
9. Ratchet riding the detent frame instead of the detent.
10. A binding or worn ratchet detent.

CREEPING: Due to too much or insufficient tension on feed rollers.

SLANTING MARGIN: Caused by uneven feed roller tension. Tension on all front feed rollers must be equal. Rear feed roller tension must be equal across platen.

WRINKLING: Caused by uneven tension on feed rollers.

See that all feed rollers have a little end play and are absolutely free on their shafts, very essential.

RIBBON MOVEMENT

OPERATED FROM UPPER U-BAR (EB-662) 220,000 to 485,000 serials. The ribbon feed is actuated on machines in this serial range by the universal bar FB-662 which is connected to the ribbon feed tube R-350 by means of the ribbon feed arm RA-591.

The ribbon feed tube extends through the machine directly back of the sub-levers and to it are attached the ribbon feed pawl arms RA-361 and the ribbon reverse links RA-351 and RA-352. The ribbon feed pawls and the ribbon reverse links RA-351 and RA-352 are in turn fastened to the underside of the top plate.

In setting the ribbon feed, it is necessary that the upper universal bar be free to travel its full distance. This travel may be adjusted by the universal bar rocker limit screw E-567 and should be such that on one complete backward and forward motion, the ribbon feed pawl engages and moves the ribbon feed ratchet RA-567 and RA-568 the distance of one tooth. See that the ribbon feed arm is fastened securely to the ribbon feed tube close to the universal bar so that the stud extends into the slot, but not so closely that it binds against the universal bar. The automatic ribbon reverse is governed by the ribbon reverse frames RA-307 and RA-308 and when the ribbon is completely unwound from one or the other of the spools, that reverse frame drops down; the stud in the end of it is engaged by the ribbon reverse link and the direction of the ribbon feed is reversed. See that the ribbon reverse trigger R-476 is not bent or caught in the folds of the ribbon and that when the ribbon spool catch springs R-485 are held back, the reverse triggers move up and down freely. Check the ribbon reverse links for position.

When the ribbon spool on either side is empty, the stud in the reverse frame on that side must rest on the reverse link just back of the turned up lip on the end of it. With the spools both out, the reverse frames must be held up about 1/16 of an inch above the reverse links. Check the feed pawls for breakage or loose springs and see that they are adjusted so that they do not both engage the ribbon feed ratchets at the same time. When the ribbon reverse rod is pushed to the right or left, one pawl engages and the other disengages. The ribbon reverse detent RA-255 should be so adjusted by the eccentric adjusting collar R-562 that it engages equally on either side of the pointed end of the reverse lever when the reverse rod is pushed to the right or left. See that the detent spring R-260 is in place.

OPERATED FROM LOWER U-BAR - (KA-507 or KA-509) 485,000 serial upwards. The ribbon feed is actuated by the operation of the Lower U-Bar to which is attached the Left Ribbon Feed Wire R-324 (Illustration 10) between Key Levers #6 and #7 and the Right Ribbon Feed Wire R-324 between Key Levers #36 and #37 which wires are so adjusted that you have about 1/32 of an inch between adjusting nuts and lower universal bar. In adjusting, be sure that wire is straight up and down; hold ribbon feed arm RA-323 up with finger, tighten screws in collar; then see that ribbon feed pawl comes all the way forward. CAUTION: If wire is set too tight, you will have a springing lower Universal Bar.

The ribbon feed Tube extends through the machine directly back of the sub-levers and to it are attached in definite positioned holes, the ribbon feed pawl arms RA-361 and the Ribbon Reverse Links RA-351 and RA-352. The ribbon feed pawls and the ribbon reverse links are in turn fastened to the underside of the top plate. (Illustration 6).

The automatic ribbon reverse is governed by the ribbon reverse frames RA-307 and RA-308 and when the ribbon is completely unwound from one or the other of the spools, that reverse frame drops down, the end of the frame is now engaged in the ribbon reverse link and the direction of the ribbon feed is reversed. See that the ribbon reverse trigger is not bent or caught in the folds of the ribbon and that when the ribbon spool catch Springs R-486 are held back with the hand, the reverse triggers move up and down freely. Check the ribbon reverse links for position.

When the ribbon spool on either side is empty, the stud in the reverse frame on that side must rest on the reverse link just back of the turned up lip on the end of it. With the spools both out, the reverse frames must be held up about 1/16 of an inch above the reverse links. Check the feed pawls for breakage or loose springs and see that they are adjusted so that they do not both engage the ribbon feed ratchets at the same time. When the ribbon reverse rod is pushed to the right or left, one pawl engages and the other disengages. The ribbon reverse detent RA-255 should be so adjusted by the eccentric adjusting collar that it engages equally on either side of the pointed end of the reverse lever when the reverse rod is pushed to the right or left. See that the detent spring 2119 is in place.

ESCAPEMENT ASSEMBLY

ADJUSTING ESCAPEMENT - To properly adjust the escapement, see that the Loose Dog EA-612 when in forward position, engages about two-thirds of its surface with tooth in escapement wheel EB-601. Face of loose dog should be adjusted perpendicular or flat on face of escape wheel tooth. This position is adjusted by loosening the dog rocker limit screw lock nut E-547 and turn the limit screw #E-546 in or out until proper position is secured. Refer to Illustration 9 for location of parts mentioned.

The escapement should trip when the face of the bars are even with the back of the typebar guide BA-517. To adjust, loosen the lock nut and turn the dog rocker bumper screw E-548 in or out until escapement trips when bars are at this print. The dog rocker limit screw E-546 should be set so that when a bar is held against the platen, there is a slight forward and backward movement of the dog rocker.

IF ESCAPEMENT TRIPS FARTHER OUT ON ONE SIDE OF KEYBOARD THAN OTHER SIDE - The Universal Bar Rocker pivoting just above the escapement dog rocker is not centered properly. Move Universal Bar Rocker in direction of side of keyboard breaking farthest form platen by releasing Universal Bar Rocker pivot set screw and backing out Universal Bar Rocker pivot in direction desired to move Universal Bar Rocker to, and coming in with opposite pivot. Universal Bar Rocker should be free and not binding. Be sure to reset Universal Bar Rocker Pivot set screw.

SKIPPING - If machines in this serial range 220,000 to 580,000, after adjusting the escapement in this manner, there is skipping between letters, inspect the dog rocker spring for breakage and proper tension. Then check the stationary dog E-521 for signs of wear. If worn, replace it. Skipping is also caused by improper tension on the universal bar rebound spring E-575 located up and just under the top plate above the Universal Bar Rocker. This spring tension is adjusted by the rebound spring tension adjusting screw which should just touch the spring when the type bar escapes giving the action a slight kickback impulse.

WOODSTOCK 220,000 to 580,000

PILING - Providing all other adjustments are correct, may be caused by the stationary dog failing to clear the escapement wheel on the forward movement of the dog rocker; inspect this and see that when a tooth of the escapement wheel is held stationary over the stationary dog, it is possible to move the dog rocker forward and back slightly. See that there are no rough spots on the stationary dog which might cause the escapement wheel teeth to hang up. The correct positioning of the stationary dog is secured by loosening the two screws holding the dog to the dog rocker and pushing the dog to the left to the point where there is a very little movement of the loose dog. Tighten it in this position. PILING is also caused by stationary and active dogs being too close together. They should be .063 thousandth apart, or the thickness of the back-space adjusting plate.

ADJUSTING ESCAPEMENT - THE TEETH ON THE LOWER U-BAR ARE USED ONLY FOR THE ADJUSTMENT OF THE ESCAPEMENT BREAK ON EACH INDIVIDUAL LEVER.

CAUTION - Before any adjustments are attempted on the escapement, refer to Illustration 10. Check the lower U-Bar to see that there is practically no end play - if so, it should be adjusted with screws K-505. IT MUST BE PERFECTLY FREE, but end shake should be adjusted out to the absolute minimum.

To adjust the escapement, adjust the Dog Rocker EB-648 using Upper Stop Screw E-546 so that the face of the Loose Dog EA-612 is flush with rear face of the Escapement Wheel EA-601.

Raise the type bar with the finger (not by the keylever), adjust the individual prong on Lower U-Bar KA-507 UPWARD TO MAKE THE ESCAPEMENT BREAK FARTHER AWAY FROM THE PLATEN: DOWNWARD FOR CLOSER TO THE PLATEN.

The escapement should take place when the type bar is within 3/16" to 1/4" from the platen when the type bar is held and moved toward the platen by the fingers (NOT BY THE KEY LEVER).

After each individual bar has been adjusted, adjust lower stop screw E-546 so that when the type bar is held against the platen WITH A KEY LEVER there is still play. CAUTION: This is important - if there is no play, the strain against the prong on the Lower U-Bar will throw the escapement out of adjustment.

MASTER ESCAPEMENT ADJUSTMENT
MACHINES EQUIPPED MECHANISM SHOWN IN ILLUSTRATION 10

MASTER ESCAPEMENT ADJUSTMENT GOVERNING UNIFORM ESCAPEMENT ALL TYPE BARS. If the escapement on all bars takes place too far from or too close to, the platen (Master Adjustments made on parts K-348; EA-326 and K-346 (Illustration 10) has slipped or loosened) the complete keyboard can again be brought into adjustment by loosening screw and nut K-348 slightly so that there is still enough friction to hold the parts from slipping; by turning screw K-346 move arm EA-326 back until the

escapement is disabled. Then, with the fingers, (not the keylever) hold the type bar from 3/16" to 1/4" from the platen and turn screw K-346 so as to move arm EA-326 forward until escapement takes place. Then again tighten screw and nut K-348 and tighten lock nut on screw K-346.

MASTER ESCAPEMENT ADJUSTMENT
MACHINES EQUIPPED WITH NEW LATEST STYLE MECHANISM SHOWN IN ILLUSTRATION 2

MASTER ESCAPEMENT ADJUSTMENT GOVERNING UNIFORM ESCAPEMENT ALL TYPE BARS. If the escapement on all bars takes place too far from or too close to, THE PLATEN, the complete keyboard can again be brought into adjustment by loosening Lock Nut 2191 and TURNING DOG ROCKER LINK ADJUSTING SCREW K-351 CLOCKWISE (To the right) makes all type bars uniformly break FARTHER AWAY FROM THE PLATEN: TURNING DOG ROCKER LINK ADJUSTING SCREW K-351 ANTI-CLOCKWISE (to the left) makes all type bars uniformly break CLOSER TO THE PLATEN.

TO COMPLETELY RESET ESCAPEMENT ADJUSTMENT: Loosen Lock Nut 2191 and turn Dog Rocker Link Adjusting Sleeve Screw ANTI-CLOCKWISE (to the left) until the escapement is completely disabled. Then, with the fingers (not the keylever) hold the type bar from 3/16" to 1/4" from the platen and turn Dog Rocker Link Adjusting Sleeve Screw K-351 CLOCKWISE (to the right) until escapement takes place. Then again tighten Lock Nut 2191.

TO OVERCOME SKIPPING
WOODSTOCKS ABOVE 580,000

CAUSES:
1. The operator is holding type bar after striking key, causing type bar to vibrate a skip.
2. Flimsy desk or table causing vibration.
3. Escapement rack not properly set in wheel pinion.
4. Stationary dog and active dog too far apart. Can be reduced by placing thinner shim between the stationary dog and dog rocker frame, or bending (be careful) the stationary dog and loose dog close together.

TO OVERCOME PILING
WOODSTOCKS ABOVE 580,000

CAUSES:
1. Flimsy desk or table causing vibration.
2. Type bar (s) sticking in guide.
3. Escapement break too close to platen or no break.
4. Space bar wire or escapement link binding in escapement.
5. Escapement dog block or lower U-Bar binding or not free on bearings.
6. Stationary dog and active loose dog too close together - Spread slightly by prying apart or install thick shim between stationary dog and dog block.
7. Erratic touch of operator in timing. (Install Type Bar Rebound Spring B-412).

TO OVERCOME CROWDING
ALL MODELS

ADJUSTMENTS: Take any gallop out of carriage movement by eliminating end play in sub-carriage and in escapement rocker.
Check rack to see that it meshes well in the escapement wheel pinion without bottoming.
Check carriage tension - should be between 1-1/4 lb. to 1-3/4 lb. for a standard 11" carriage.

Check desk or table to see that carriage is not traveling up-hill.
Check desk or table for flimsiness.

TO OVERCOME SHADOWING
ALL MODELS

Install Type Bar Rebound Spring B-512, or if one already installed, bend out, away from guide, top of ring to provide greater resistance against bar.
Increase tension on key lever adjusting screws, approximately ½ to 1 full turn.

BACK SPACE (Illustration 1)

Before attempting to adjust the Back Space Mechanism, check the Back Lash Pawl E-542 (Illustration 10) on the escapement dog rocker. When the escapement wheel turns it should just slip under the teeth without hanging up and permitting only a little back play on the escapement wheel. It is adjusted by loosening the Back Lash Pawl Screw 2006 (Illustration 10) and moving the pawl up or down as may be necessary, then locking in place with screw.

CHECK the two bracket screws E-550 - if machine is between 580,000 and 590,000, see Illustration 1 upper right, to see if loose. If these screws are loose it will throw your Back Space out of adjustment. These screws should be tight.

The Back Space Pawl Spring M-4 (See Illustration 1) should have enough tension to pull the pawl erect when the back space key is depressed, but should not have so much that it will hold up the pawl when the key is at rest.

The Back Space Bell Crank is adjustable with eccentric Nut M-378 and Screw 2089. Back space Pawl MA-531 should engage rack about 2/3 of the length of the rack teeth. If it does not, raise the bell crank by eccentric nut to proper position, being sure that nut is tight on lock screw.

The Back Space Plate M-524 is attached to the top plate with two screws M-25. The screw holes in the plate are large enough to allow for adjustment. The plate should be set so that when the back space key is depressed slowly, the back space pawl MA-531 will stop against the end of the plate a little after the escapement wheel tooth has moved over the loose dog.

ADJUSTING BARS TO ABUTMENT

To prevent shadowing, the type bars must strike the abutment on the segment but not so much that it is impossible to secure a clear sharp impression with a normal touch. To check this, holding a piece of thin paper between the abutment and the type bar as it is held against the platen, pull the paper out, noticing the drag, which should be the same on all bars. If the majority of the type bars are set too much or too little on the abutment, move the sub-carriage forward or back as may be necessary, by first loosening the Shift Link Screws C-83 (Illustration 5) enough to enable the shift link collars C-488 to be moved. Individual bars may be set on the abutment by peening them with peening pliers at the point of contact with abutment.

ADJUSTING KEY LEVER SPRINGS

With the type bars out, tighten or loosen the key lever springs so that there is just enough tension on them to bring the key levers up firmly to the top of the key lever comb. Type bars and sub-levers must be perfectly free in their bearings.

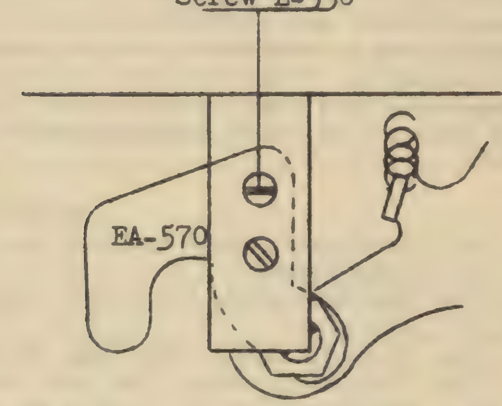
SHIFT LEVERS AND SHIFT LOCKS

Check the Shift Levers KC-38 and KC-39 to ascertain that they are straight and not binding in the comb. The end of the shift levers must be so formed so as not to strike the sides of the base posts. Should they strike the sides of the base posts, it would cause the carriage to hang up after shifting.

The shift lock is adjusted by turning the shift Lock Cam studs K-60, the heads of which are milled to form a flat. If the shift lock does not hold securely, loosen the nut and turn the cam towards the front of the machine so that the shift lock key can be depressed further, thereby locking the carriage on the upper case more securely. When adjusted properly, it should be necessary to only slightly depress the shift key to release the lock. The shift must lock easily and release from either side of the keyboard which is adjusted at right end of rebound arm rod CB-671.

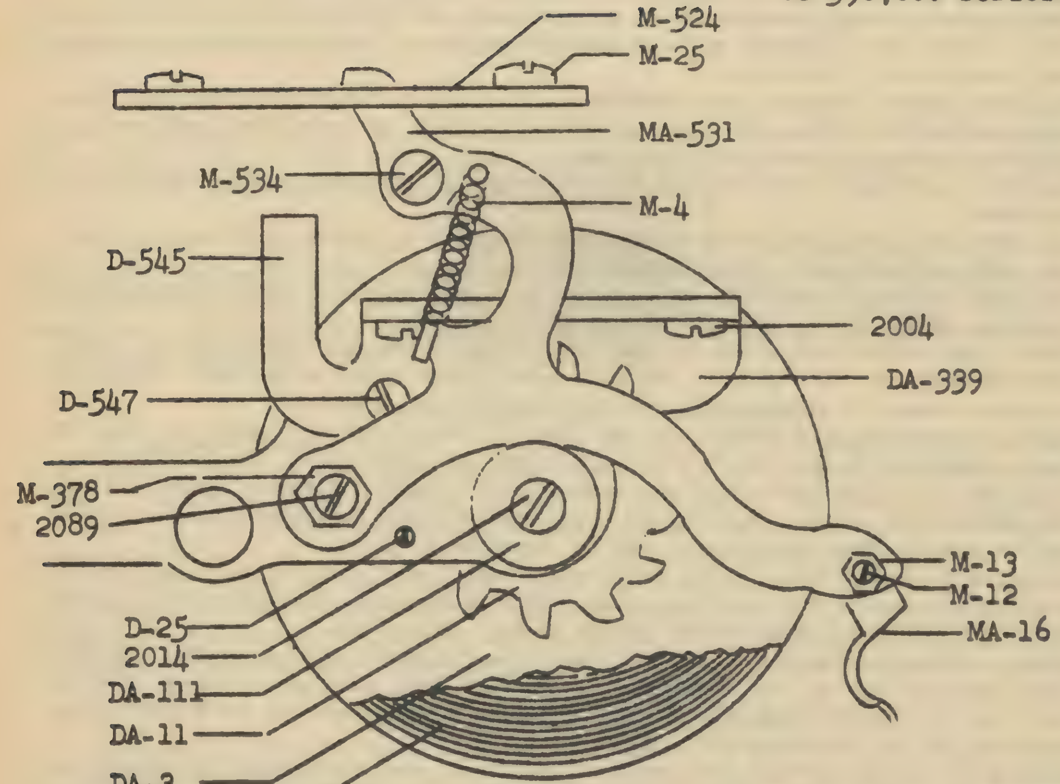
INSPECTION ROUTINE

1. Check all screws and nuts for tightness. Be careful not to change adjusting screws.
2. See that there is no lost motion or binding in carriage rails. Check for end play.
3. Test for proper carriage tension and ease of operation.
4. Test Feed rolls. See that they are free on shafts and bearing evenly and that there is no slipping or wrinkling of paper; also that the paper feed release lever releases properly.
5. Check line space mechanism to see that it is spacing properly on single, double and triple spacing.
6. See that there is no slipping in variable and that it releases easily; also that permanent soft roller is functioning properly.
7. Test platen to see that there is no end play and that it spins easily when feed rollers are released with ratchet disengaged. See that platen is true and platen shaft straight.
8. See that paper fingers slide easily on the paper finger bar and that they have the proper tension - or - check the bail to see that rollers are uniform against platen on both sides.
9. See that carriage rack release levers properly release from either end of carriage.
10. See that left marginal stop is so adjusted that it stops carriage at point set with no banking or running over.
11. See that the right marginal stop rings bell properly and locks carriage and releases after three spaces.
12. Check tabulator mechanism to see that stops push out when keyset is depressed and that they return properly when clear lever is pulled. See that carriage stops at points at which tabulator stops are set.
13. Check escapement dog rocker to see that it moves easily; that is, that it rocks back and forth freely with a minimum of side play. See if dogs are worn and if type bars trip escapement at proper distance from platen.
14. See that back space pawl engages in rack proper and that carriage back spaces easily when back space key is depressed.
15. Check carriage motion. See that upper and lower case characters are in perfect alignment and that carriage shift lock works properly from either side and releases when either shift key is depressed.
16. Check ribbon mechanism. It must feed easily and reverse on ONE STROKE. There should not be any binding or too much lost motion in spool shafts. See that bichrome mechanism is so adjusted that there is no bleeding or cutting off of the tops of letters.
17. Test line finder scale for proper position, and also card device which must hold card firmly (when device is engaged) without binding carriage.
18. See that there is no binding of key levers in comb or of type bars in the segment or guide and that bars are set on abutment ring and in alignment.
19. See that machine, type, feed rolls and platen are clean. Oil bearing surfaces carefully, excepting, of course, segment slots, which must never be oiled.



BACK SPACE BRACKET

(This type bracket used on only few machines in 580,000 to 590,000 series.)



BACK SPACE-DRUM BRACKET ASSMBLY

Illustration 1

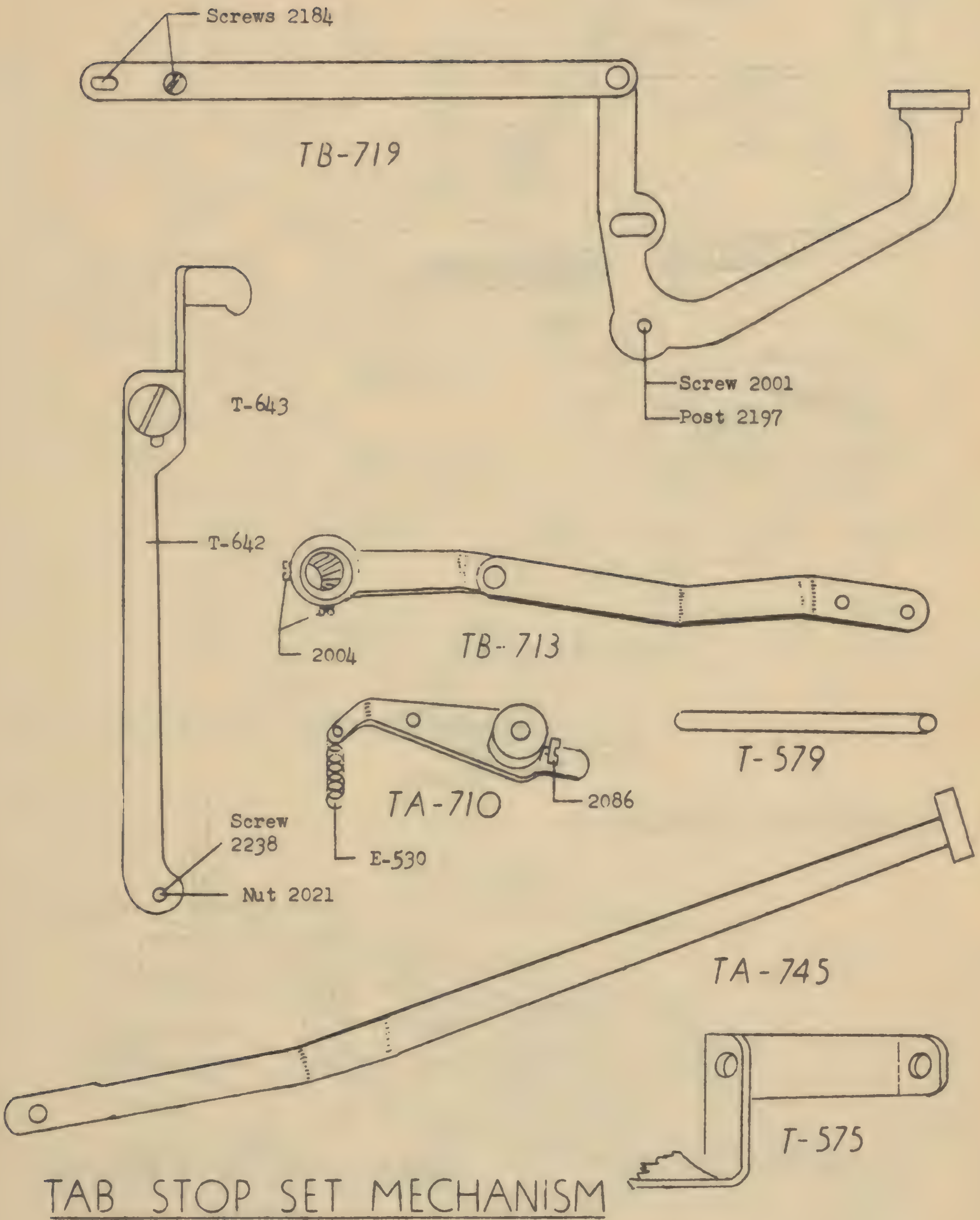
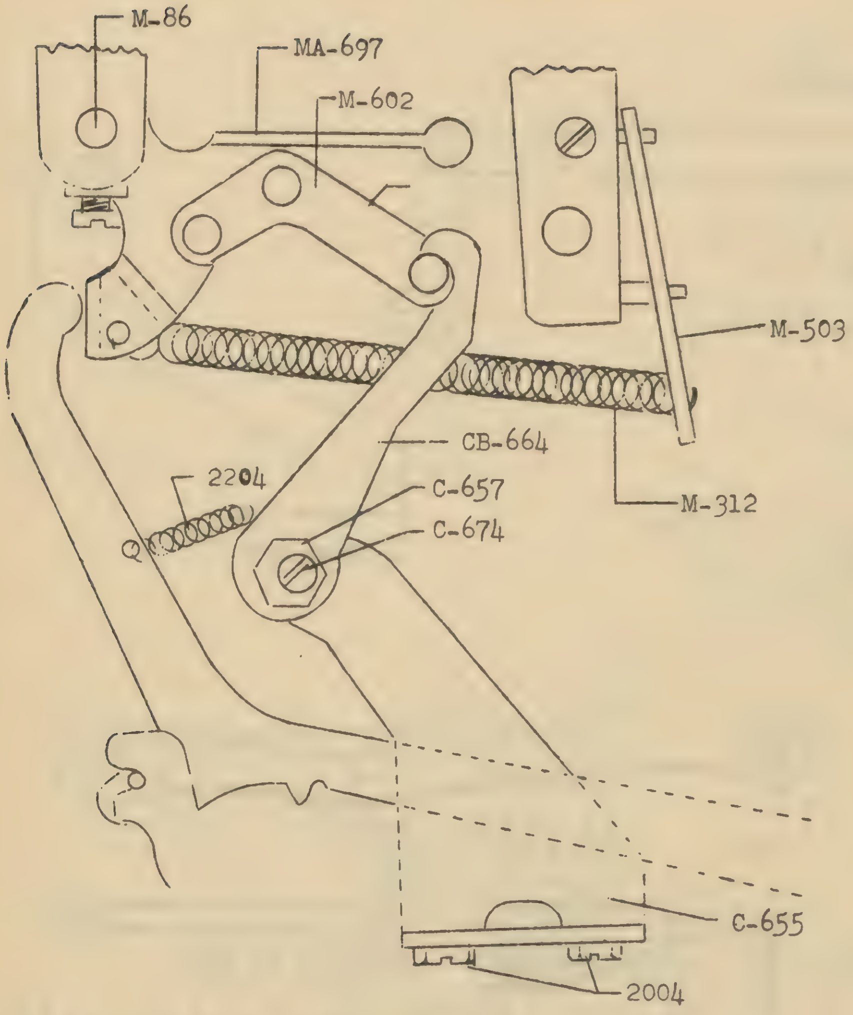
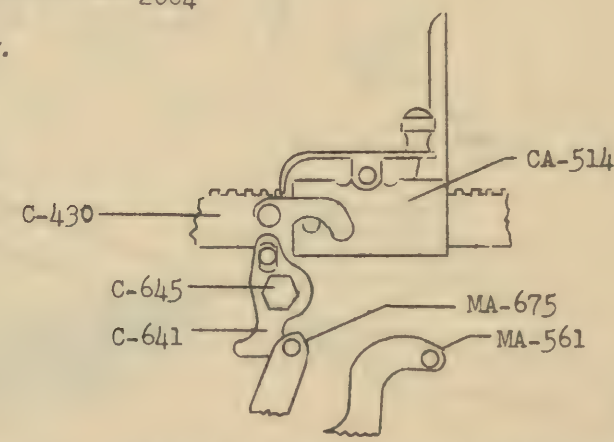


Illustration 2

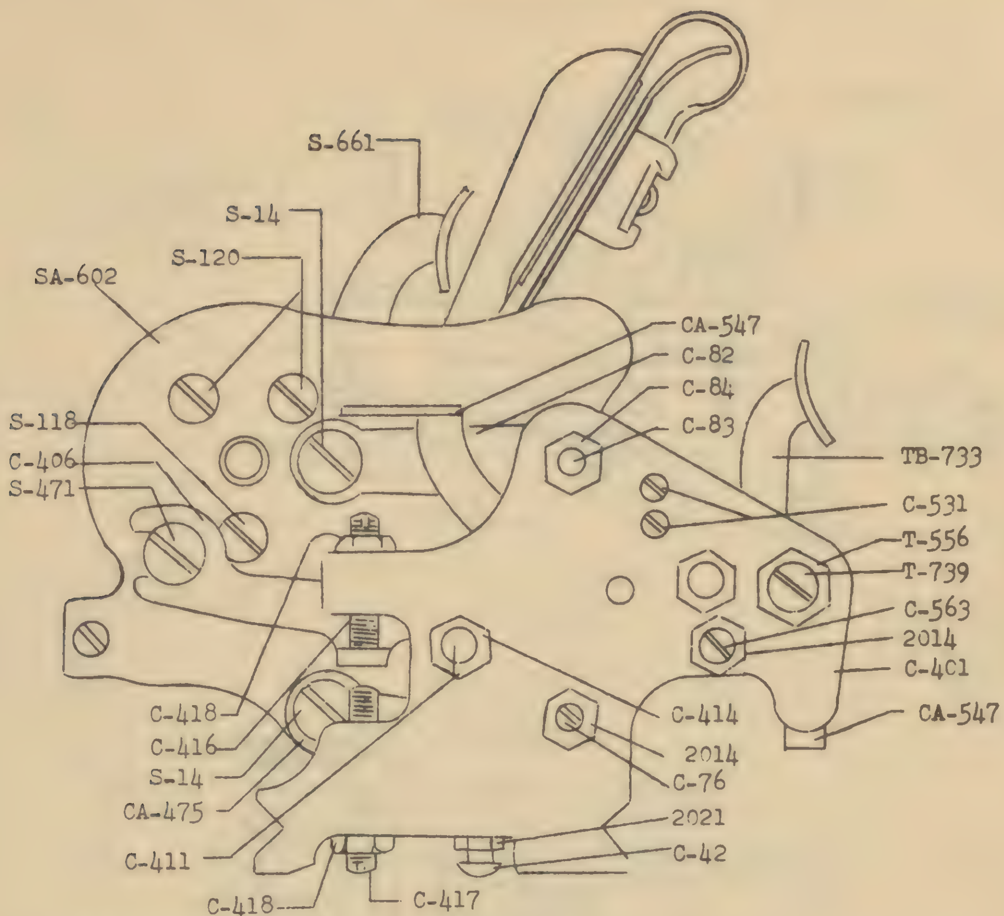


REBOUND LATCH &.



REAR VIEW R. H. MARGIN STOP

Illustration 4



CARRIAGE RIGHT END

MARGIN STOP & RELEASE LEVER MECHANISM

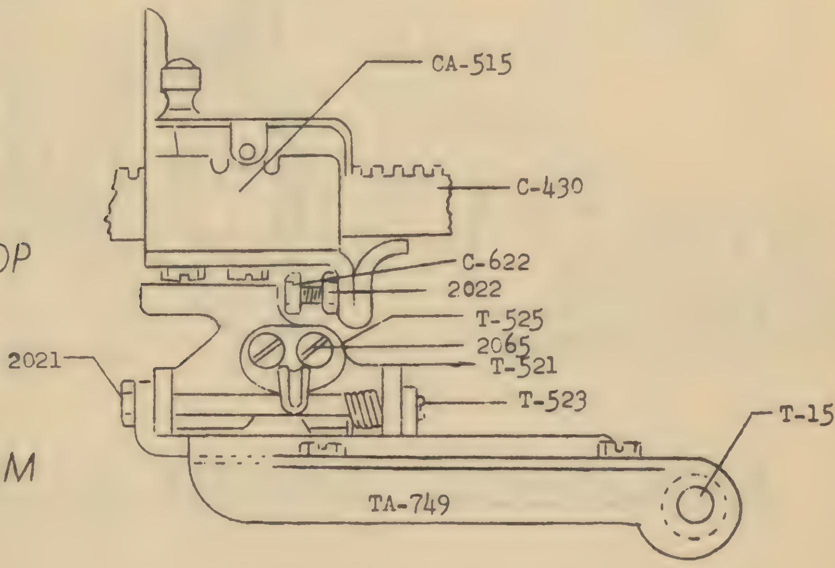
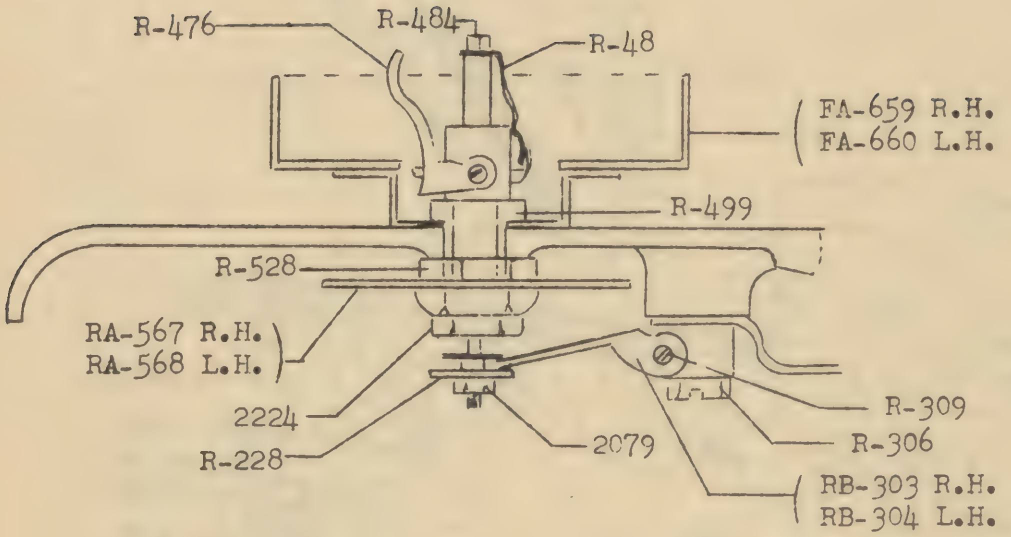
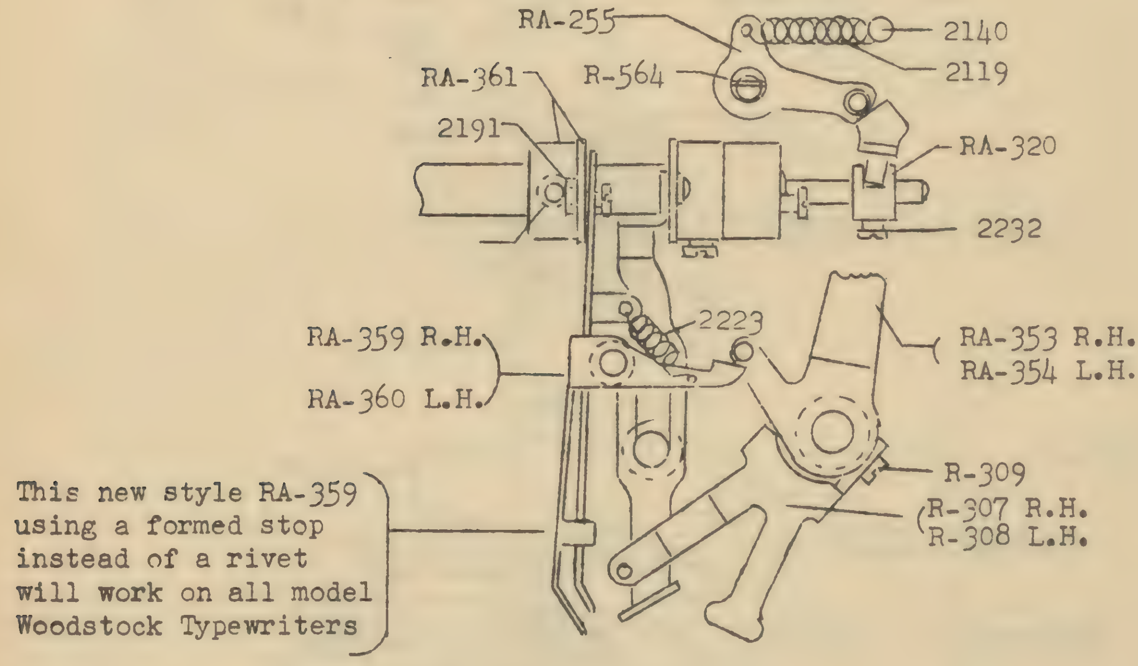


Illustration 5





RIBBON FEED & REVERSE MECHANISM

Illustration 6

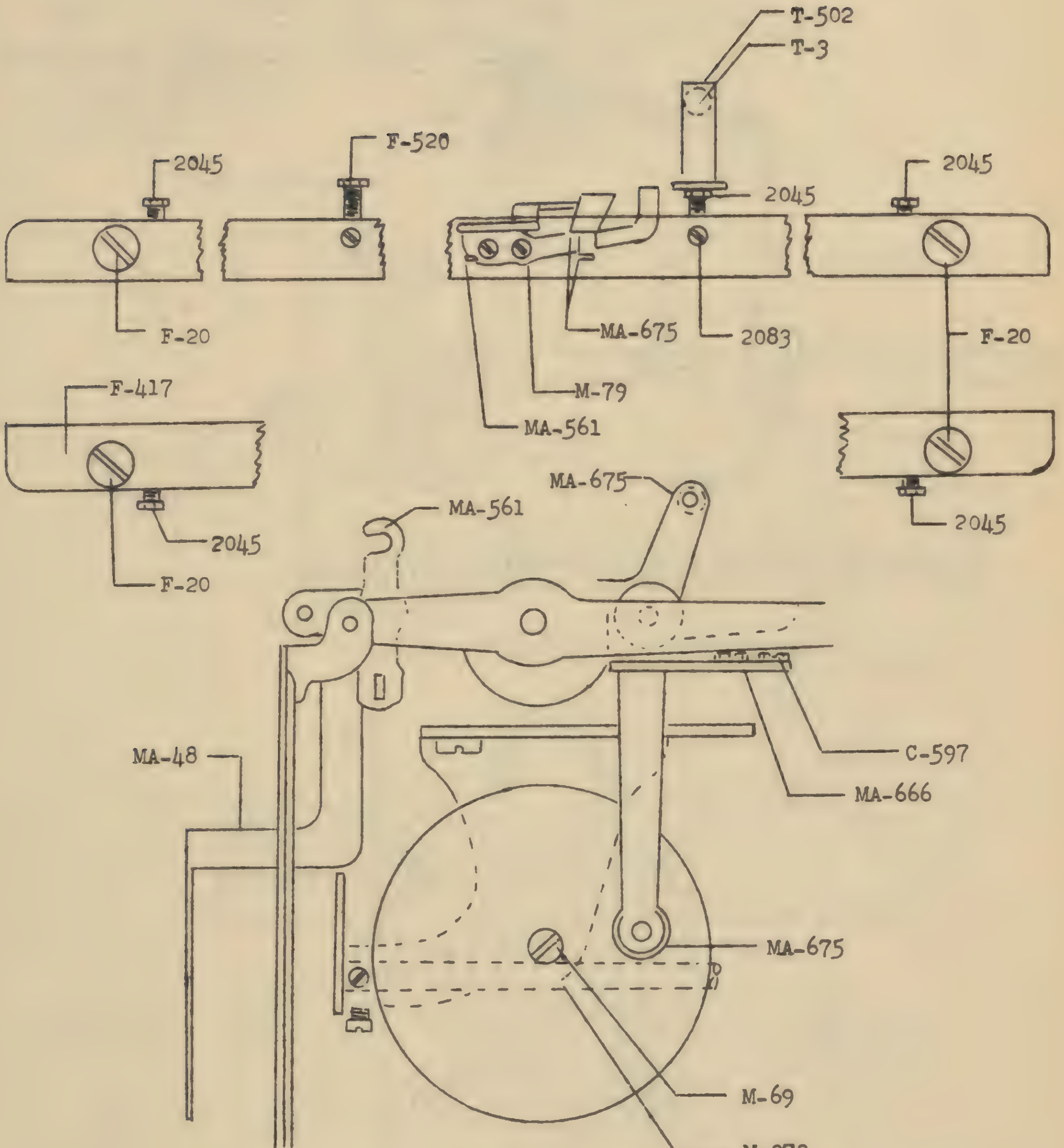
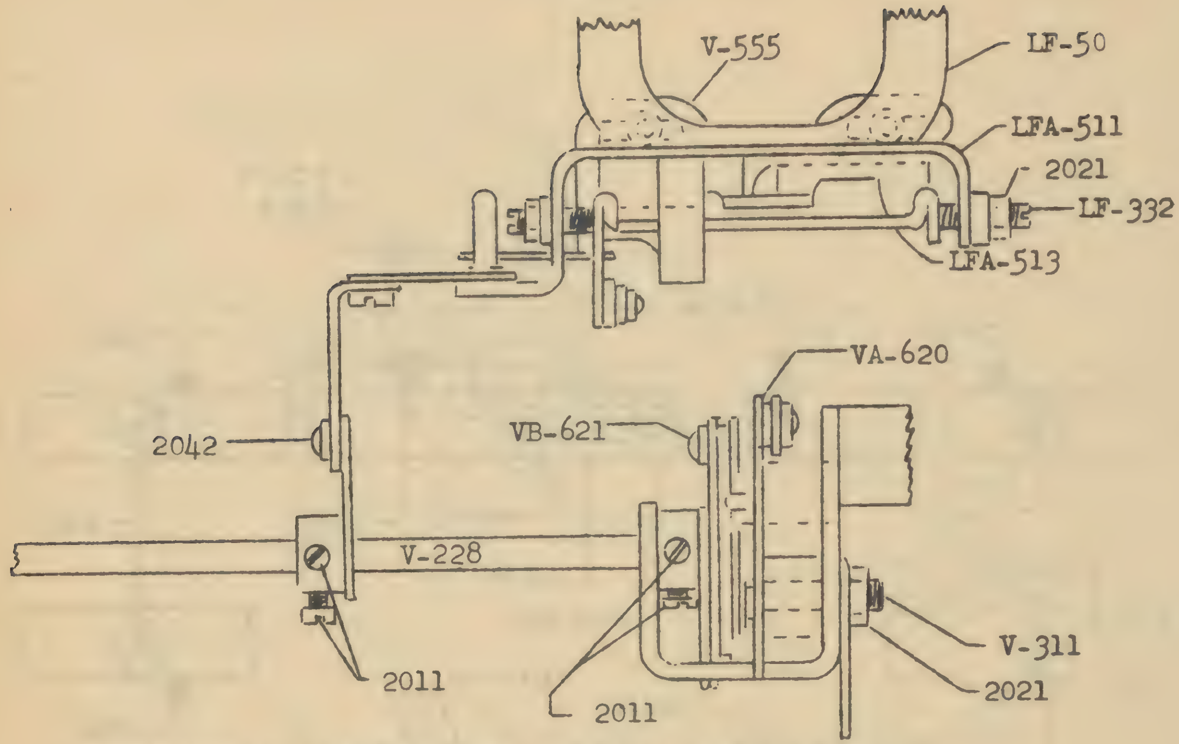


Illustration 7



RIBBON VIBRATOR MECHANISM

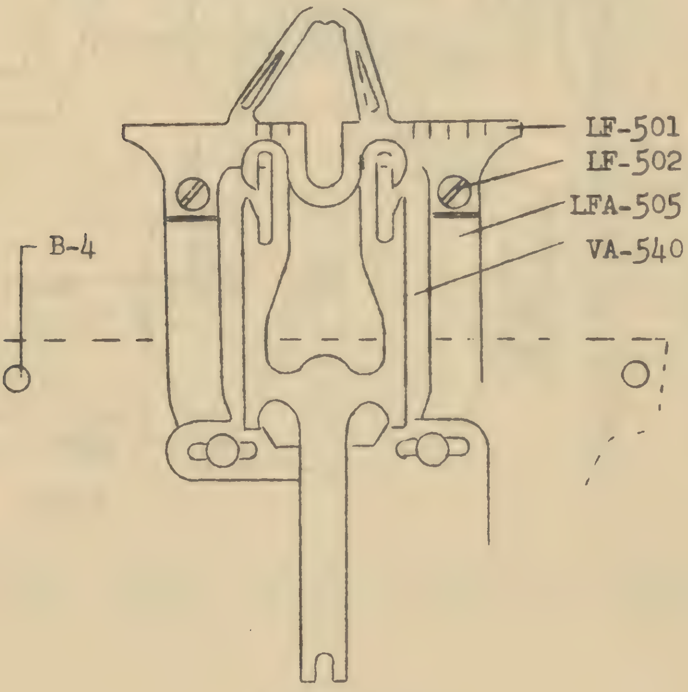
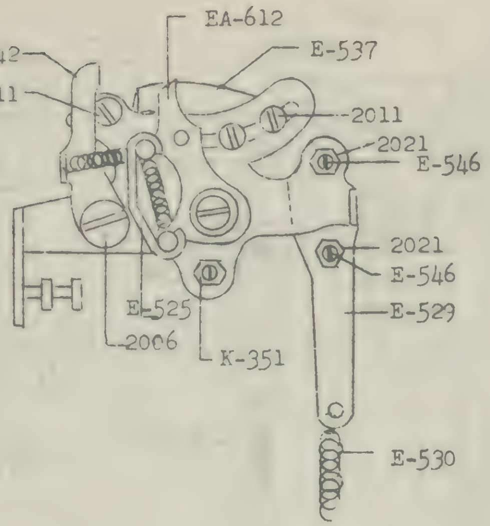


Illustration 8

NEW STYLE
DOG ROCKER

Providing Escapement Adjustment with Dog Rocker Limit Adjusting Screw K-351.



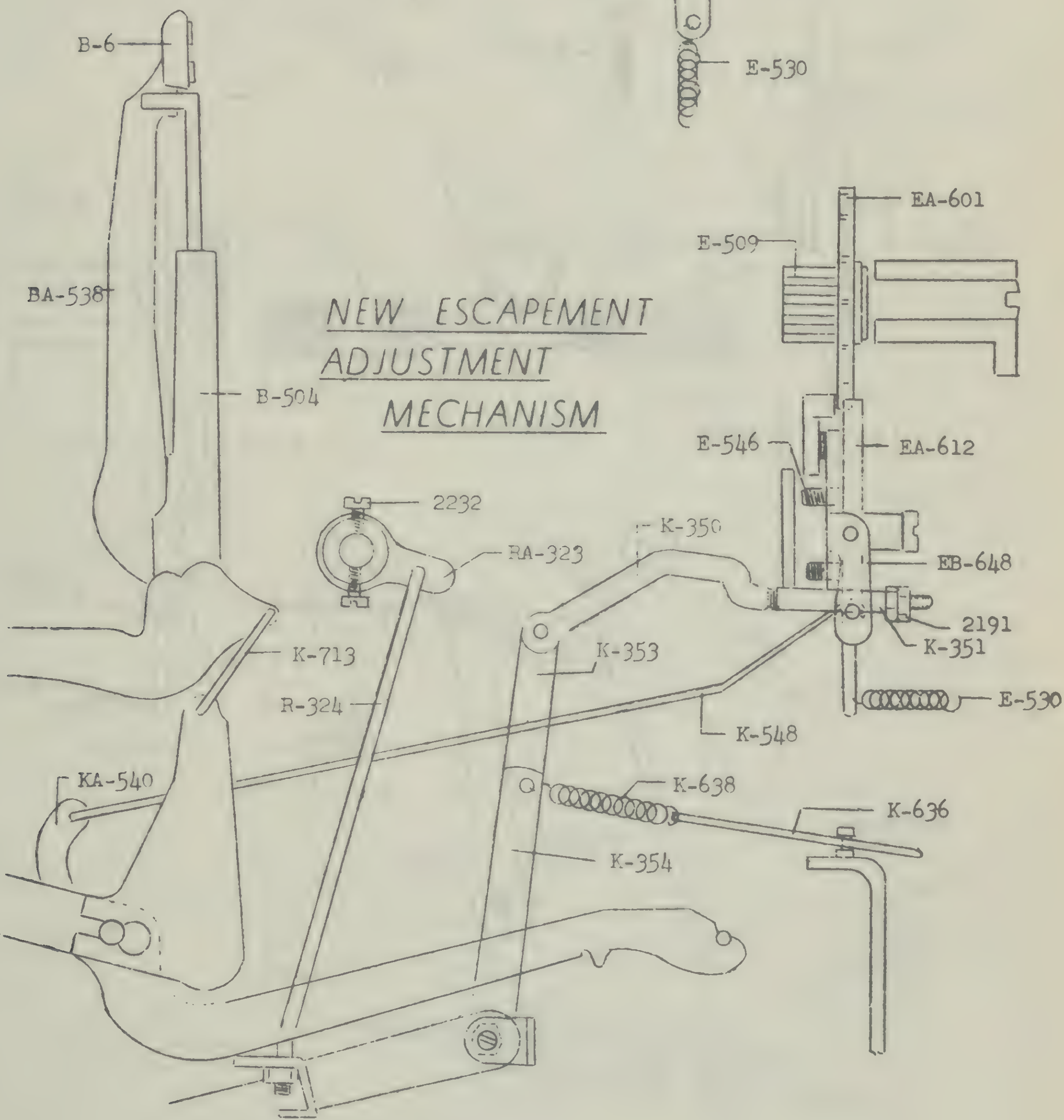


Illustration 9

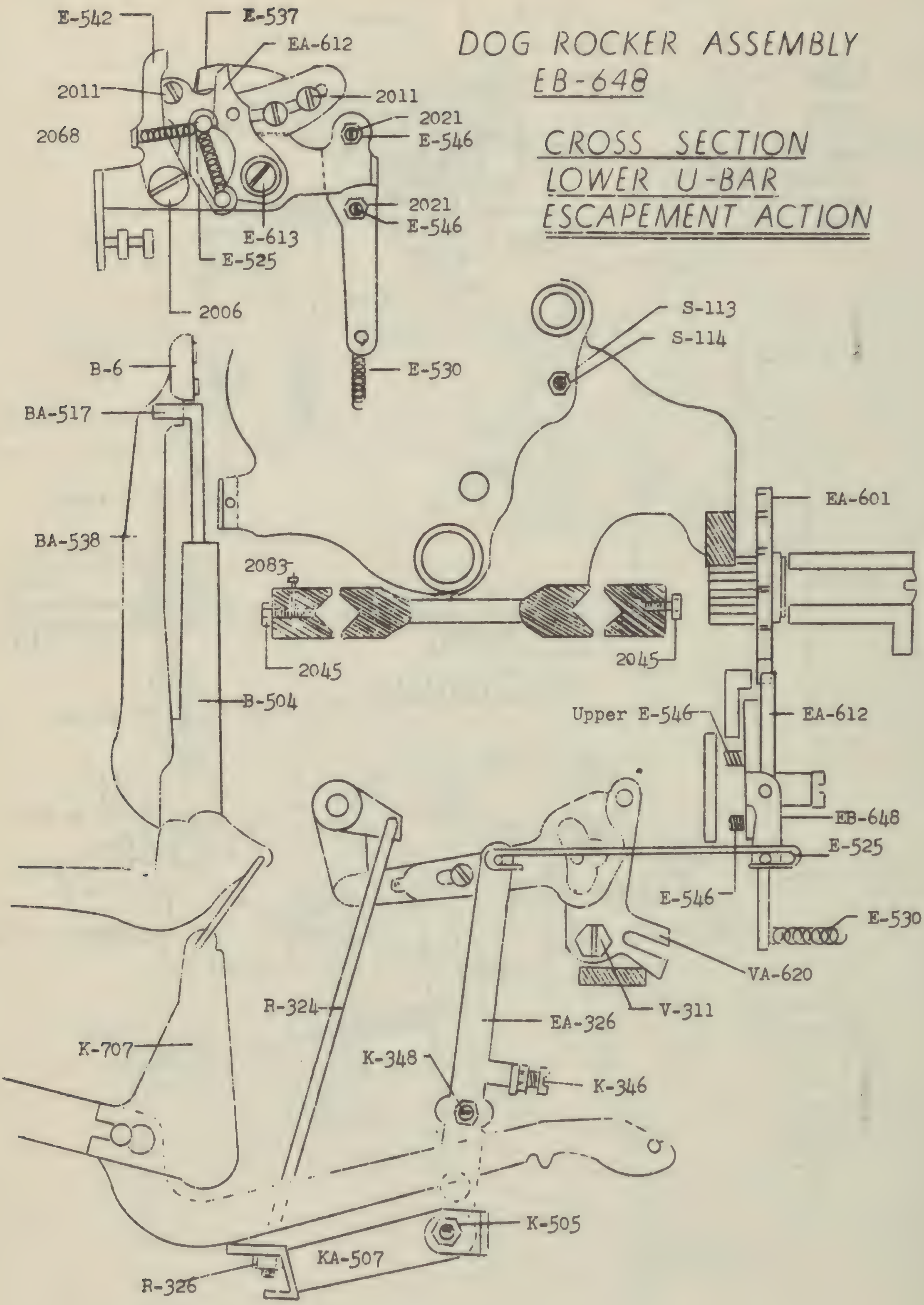


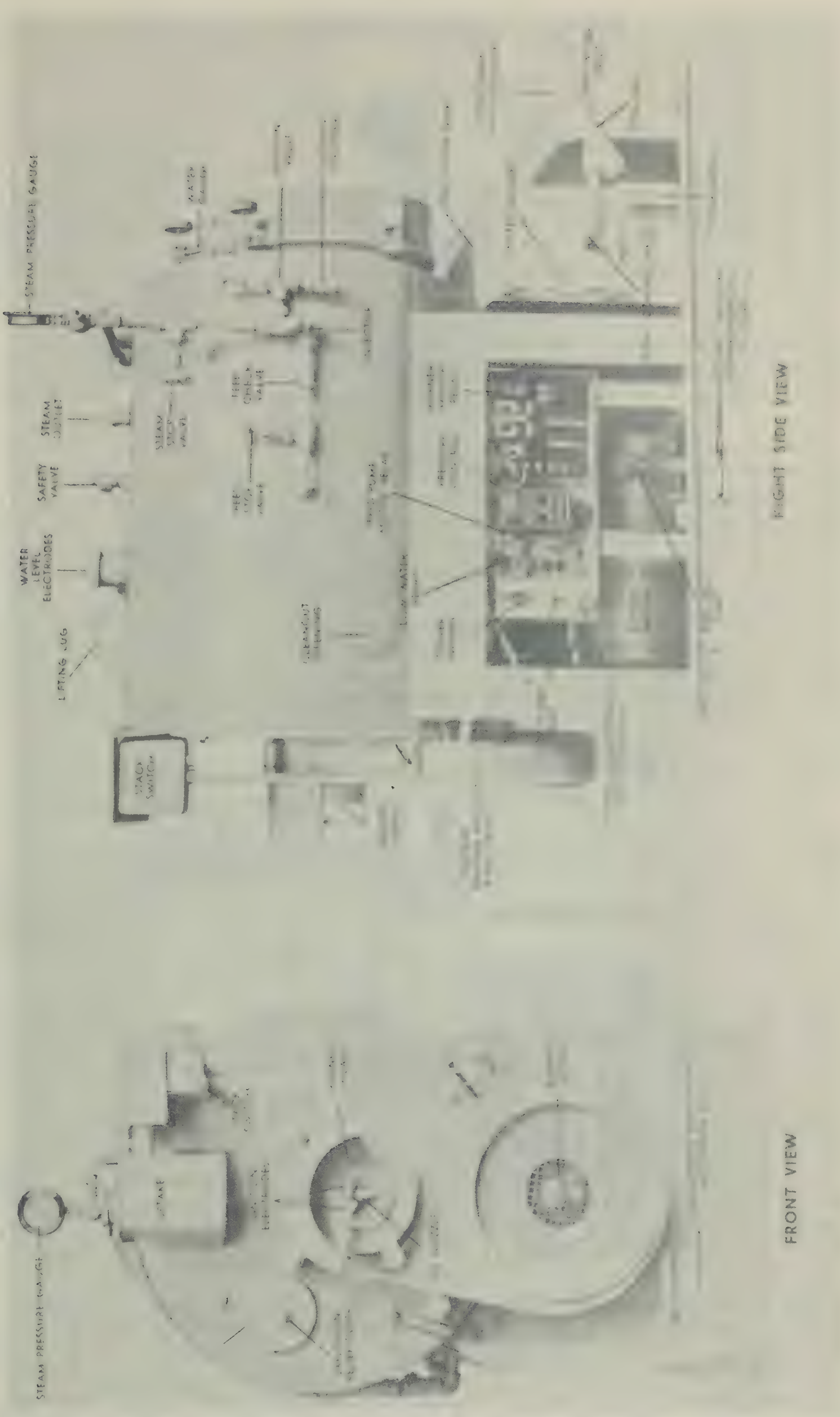
Illustration 10

CHAPTER X

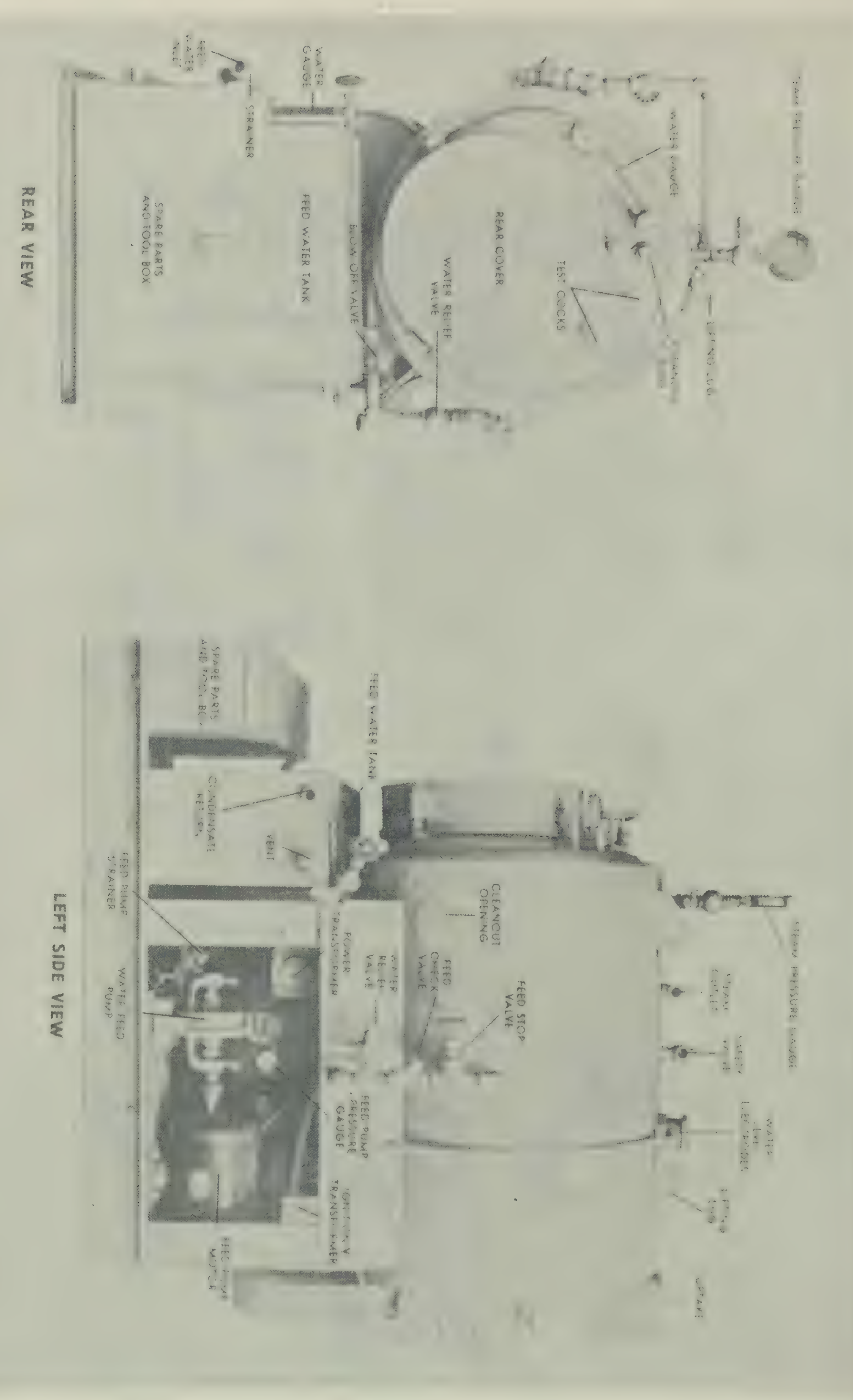
STEAM GENERATORS

SECTION I

CYCLOTHERM



CYCLOTHERM STEAM GENERATOR C-12



CYCLOTHERM STEAM GENERATOR C-12

CYCLOTHERM

GENERAL DESCRIPTION C-12

Capacity Steam lbs/hr. (212° F)	420
Design Pressure psi	100
Working Pressure psi	100
Type of Burner	oil pressure atomizing
Burner Capacity, G.P.H.	4
Fuel Pressure at nozzle psi	100
Fuel Pump Capacity, G.P.H. against 100 lb. pressure	13
Ignition Electric primary 110v. secondary 10,000 v.	
Blower Motor 3/4 h.p. single phase, 110-220 v. A.C.	1750 R.P.M.
Water Feed Pump Motor 3/4 h.p. single phase, 110-220 v. A.C.	3450 R.P.M.
Water Feed Pump Capacity G.P.H. against 100 lb. pressure	100

CYCLOTHERM STEAM GENERATOR is a boiler unit completely equipped with oil burner and all controls necessary for full automatic operation. The unit is self-contained and fitted for immediate operation when connected to electrical, fuel and fresh water lines.

BOILER is of steel construction built in conformity with boiler construction codes as required. The boiler shell is cylindrical. The combustion chamber or furnace is a centrally located cylindrical steel tube. The return passes consist of a row of small firetubes placed concentrically about the furnace. The heating surfaces are so arranged in the boiler as to impell rapid circulation of the surrounding water, resulting in a stable water level, free and dry steaming-out, minimizing the collection of sediment and scale on the heating surfaces. The boiler shell is provided with cleanout openings. Access to the furnace and return tubes is readily had by removing the rear cover. The boiler stands on a rugged structural steel base provided with holed for bolting to the desk or a foundation when required. The boiler shell is insulated and covered with a stell jacket.

BOILER TRIM consists of a steam gauge, water level gauge, test cocks, steam safety valve, bottom blow-off valve and feed stop and check valves.

REAR COVER of the boiler is removable for inspection and cleaning of the furnace and return tubes. It is lined with "Firecrete", a product of the Johns Manville Co.

REAR SCROLLS of chrome and nickel alloy are placed between the boiler head and rear cover, held in place by stud volts. The scrolls need not be removed when cleaning the boiler but must be removed for purposes of tube replacement or repair. The function of the scrolls is to impart a vertical motion to the hot gases passing through the return tubes; thereby effecting a high transfer of heat, with resulting economy.

FRONT ASSEMBLY consists of adequately sized cover forming a flue box and flue connection; a burner and blower housing with blower wheel and drive shaft; burner head with oil atomizing nozzle and ignition electrodes. The entire front is demountable for general repairs, and the burner head and nozzle bracket may be removed separately for access to the furnace and cleaning of the nozzle and ignition electrodes.

BURNER is supplied with fuel oil by a fuel pump which draws the oil from the tank and pumps it to the atomizing nozzle with a high pressure.

The fuel oil is broken up by means of an oil atomizing nozzle, and ignited by an electric spark. Disassembly of the oil nozzle will show that tangential slots lead the oil to the tip in a whirling motion so as to inject the fuel oil in a cone

shaped spray into the furnace. A small amount of air is introduced around the nozzle to keep it cool and free of oil and carbon.

Air for combustion of the fuel is supplied from a blower creating sufficient pressure to burn the fuel and to force the gases through the boiler. A stack, therefore, is not necessary for operation of the unit.

BURNER MOTOR AND OIL PUMP are directly connected by a flexible coupling. The motor shaft is provided with a "V" pulley to drive the blower through a "V" belt. The oil pump, fuel oil strainer and pressure regulating valve comprise the fuel handling assembly. Inlet and return connections are provided for pipe connections with the fuel oil tank. A copper tube leads from the nozzle connection to the oil atomizing nozzle. When connected with suction and return lines to fuel tank, the pump need not be primed for starting. The fuel pump has much greater capacity than the firing rate of the unit; the oil firing rate is fixed by the size of oil nozzle and the balance of oil is released to the tank through a pressure regulating valve.

IGNITION TRANSFORMER supplies 10,000 volt current for ignition spark. High tension wires have a snap on connector to the electrodes - Electrode spark gap should be set for 3/16 inches.

CONTROLS consisting of a stack switch (burner relay), pressure limit switch, water level relay, burner motor relay and oil solenoid valve, provide full automatic operation of the unit. The Stackswitch contains a relay for starting and stopping burner. Upon ignition or flame failure the stackswitch shuts off the burner and in that event the burner must be started by depressing the reset button in the cover. The pressure limit switch stops the burner in accordance with the pressure setting and starts the burner when boiler pressure drops to the lower differential setting of the switch.

A water level relay operates in conjunction with the water level electrodes and provides for operation of the boiler feed pump and safeguards against low water in the boiler.

The water level relay is equipped with transformers to supply low amperage current to the water level electrodes extending through the top of the boiler shell to the water level. The boiler feed pump starts when water leaves the middle electrode and stops when water reaches the upper electrode. The oil burner stops if water level drops below the lower electrode, and the burner can only be started again by filling to normal water level and depressing the reset button on cover of switch. The oil solenoid valve allows oil to pass to the burner when burner starts, and stops oil flow immediately upon interruption of the burner electric circuit thus insuring a quick, clean shut-off.

INSTALLATION INSTRUCTIONS

1. Bolt the unit to desk or foundation according to foundation plan. Base of boiler is provided with bolt holes.

2. Connect steam and water lines to respective connections as shown on assembly plan.

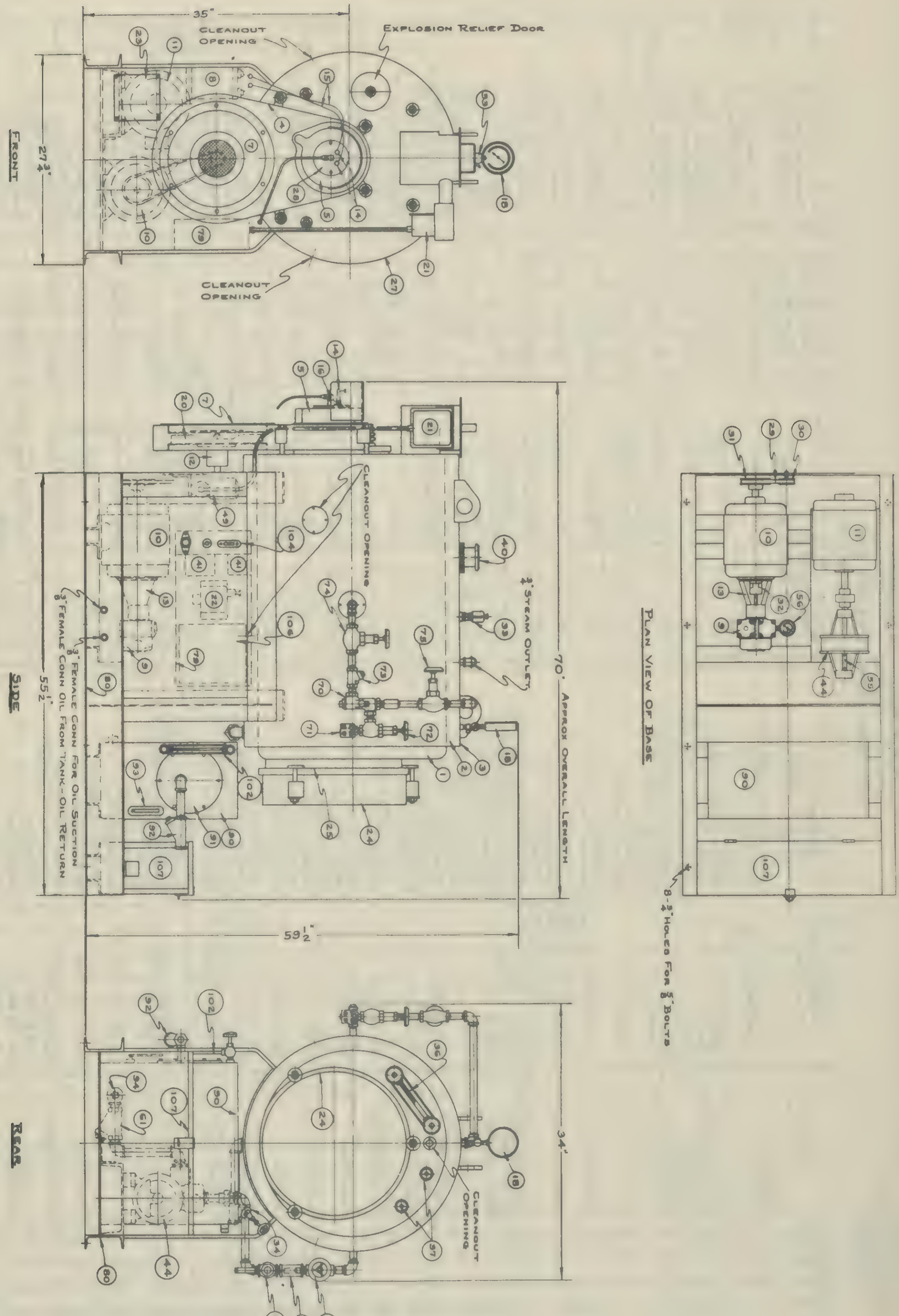
3. Connect oil supply and return lines from oil tank to inlet and outlet connections of oil pump as shown on assembly plan. Lines to be at least as large as connections to oil pump. It is recommended that lines, where possible, be continuous tubing to avoid joints which may leak. Oil supply line to pump should be connected near bottom of tank. Supply and return lines must be provided with shut-off valves.

4. Connect electric supply lines to the unit as shown on the wiring diagram.

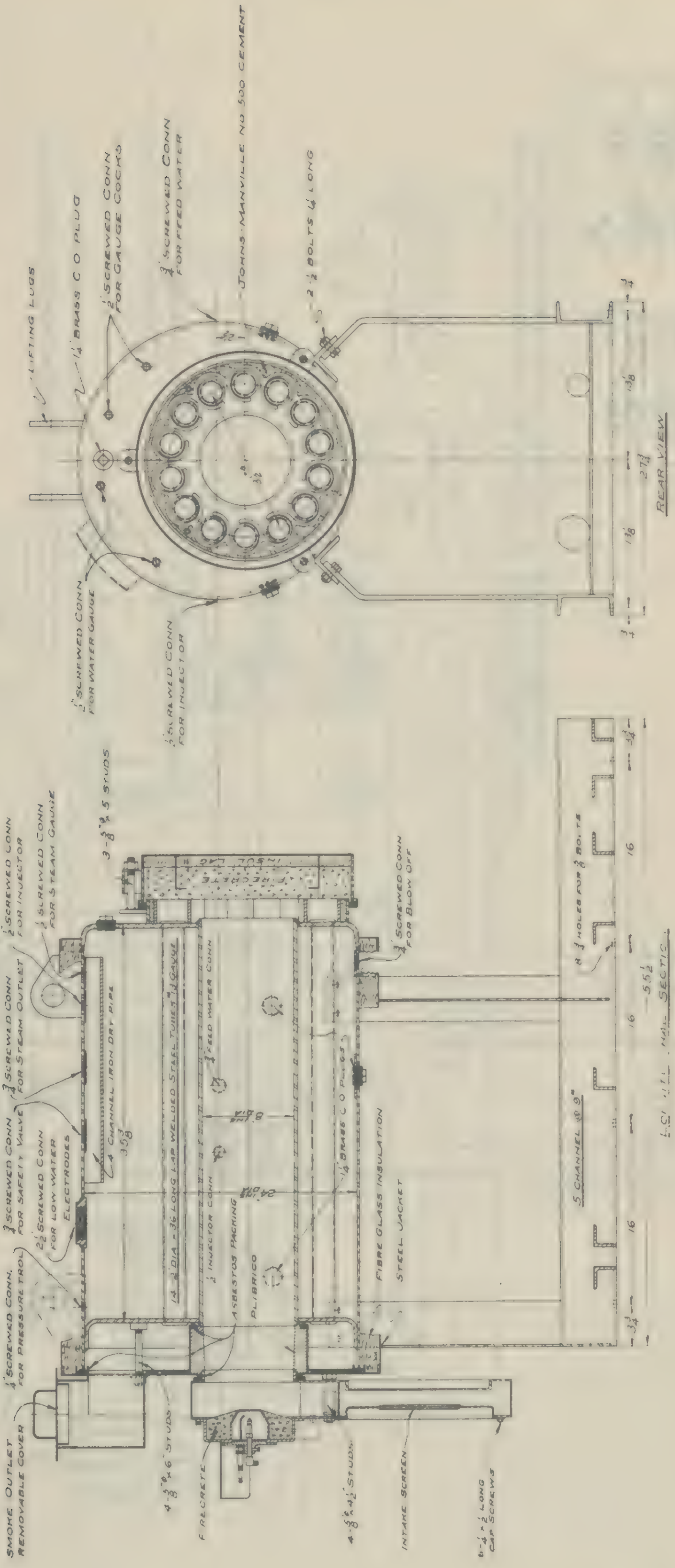
Plan Reference
AMES IRON WORKS
Plan C-281A

LIST OF MATERIAL AND EQUIPMENT FOR CYCLOTHERM STEAM GENERATOR C-12

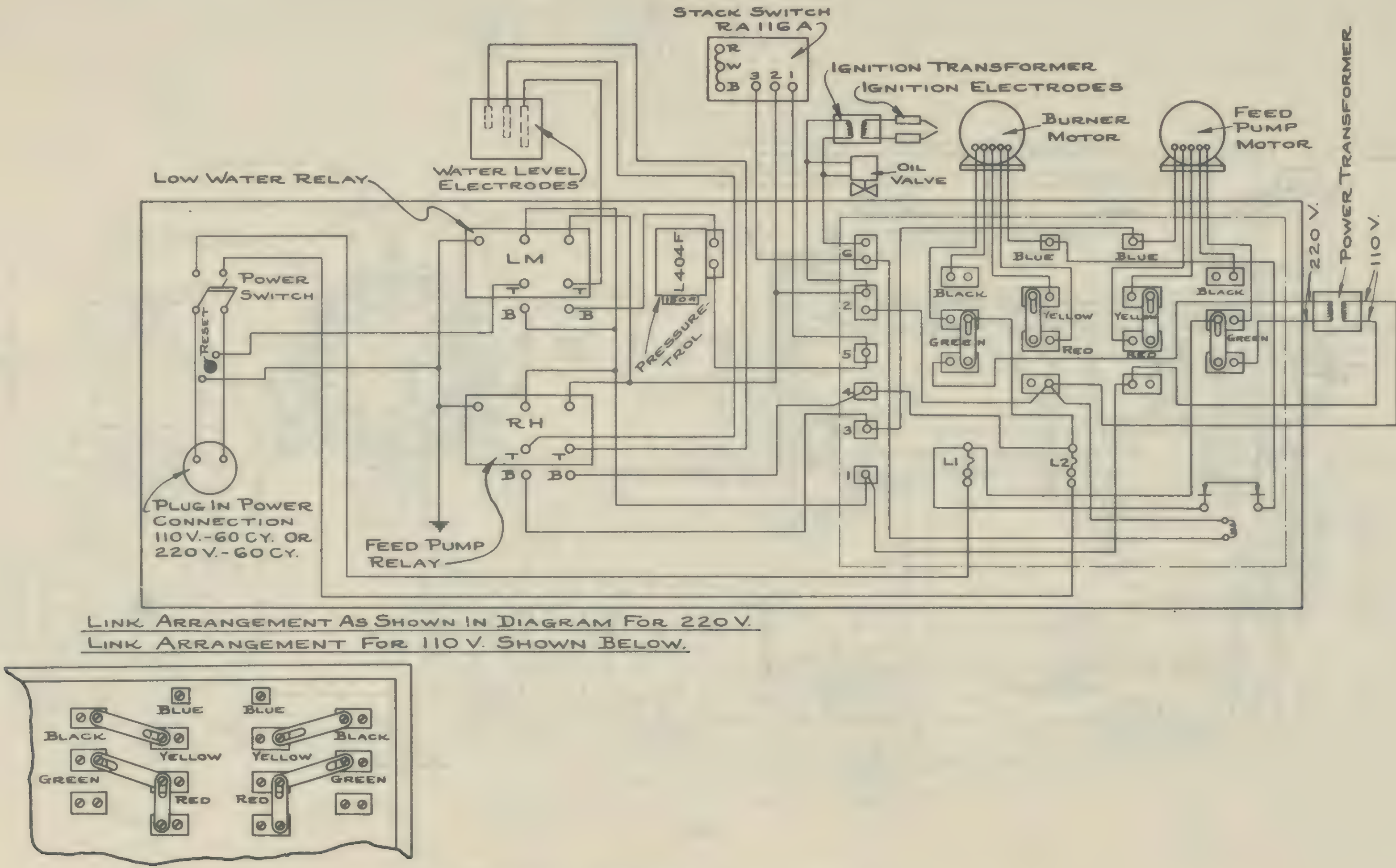
Part No.	No. of Parts	Material	Catalog Number, Type, Model	Manufacturer's Name & Address
1	1	Boiler	C-12	Ames Iron Works, Oswego, N.Y.
2	1	Insulation	Fibre Glass 1½" Thick	Owens Corning Glass Co. Toledo, Ohio
3	1	Jacket	Steel	Ames Iron Works, Oswego, N.Y.
4	1	Burner-Blower Housing	Steel	Ames Iron Works, Oswego, N.Y.
5	1	Burner Head	Steel	Ames Iron Works, Oswego, N.Y.
7	1	Blower Cover	Steel	Ames Iron Works, Oswego, N.Y.
8	1	Ignition Transformer	Type 311 AEF	Webster Electric Co., Racine, Wis.
9	1	Oil Pump	IT-A3101	Webster Electric Co., Racine, Wis.
10	1	Burner Motor	3/4 H.P. Frame 182, Cap. Type, 1750 rpm, 110 220V.	Marathon Electric Co., Wausau, Wis.
11	1	Feed Pump Motor	3/4 H.P. Frame 184, Cap. Type, 3450 rpm, 110/220V.	Marathon Electric Co. Wausau, Wis.
12	1	Blower Bearing Assembly	C-48 Cast Iron	Ames Iron Works, Oswego, N.Y.
13	1	Oil Pump Bracket	C-12-13, Cast Iron	Ames Iron Works, Oswego, N.Y.
14	2	Ignition Electrodes	STT 38	Northwest Auto. Products Minneapolis, Minn.
15	2	Ignition Cables & Connectors	7 MM #239	Packard Electric Co., Warren, Ohio
16	1	Oil Nozzle	4 45°	Hago Products, Newark, N.J.
18	1	Steam Pressure Gauge	3½" I.B.B.R. 0-150#	Marshalltown Mfg. Co., Marshalltown, Iowa
19	1	Water Relief Valve	Size 3/4" Fig. 10 Set at 115 #	Kunkle Valve Co., Fort Wayne, Ind.
20	1	Blower Wheel	12" Dia. x 1"	Spencer Turbine Co., Hartford, Conn.
21	1	Stack Switch	RA116A	Minneapolis-Honneywell, Minneapolis, Minn.
22	1	Pressuretrol	Model L404-F	Minneapolis-Honeywell, Minneapolis, Minn.
23	1	Name Plate	Zinc	Ames Iron Works, Oswego, N.Y.
24	1	Rear Cover	Steel	Ames Iron Works, Oswego, N.Y.
25	1	Rear Scroll	C-15-Nickle Chrome-Xite	General Alloys Co., Boston, Mass.
27	1	Front Cover	Steel	Ames Iron Works, Oswego, N.Y.
28	1	Nozzle Bracket	C-40-28, Cast Iron	Ames Iron Works, Oswego, N.Y
29	1	V-Belts	Type #1340	Allis-Chalmers Co., Milwaukee, Wis.
30	1	Blower Pulley	AK-23 5/8" Bore	Browning Mfg. Co., Maysville, Kentucky
31	1	Motor Pulley	AK-41 3/4" Bore	Browning Mfg. Co., Maysville, Kentucky
32	1	Oil Pump Coupling	Size 1/2" x 5/16" Type #1-A-070	Lovejoy Flexible Coup. Co., Chicago, Ill.
33	1	Safety Valve	Fig. #23 Size 3/4" Set at 105#	Kunkle Valve Co., Fort Wayne, Ind.
34	1	Blow Off Valve	Fig. 224 Size 3/4"	Ohio Injector Co., Wadsworth, Ohio
36	1	Water Gauge	Fig. 19G4 1/2"	Essex Brass Co., Detroit, Mich.
37	2	Gauge Cocks	Fig. #25 1/2"	Essex Brass Co., Detroit, Mich.
38	1	Feed Stop Valve	Fig. 520 3/4"	Ohio Injector Co., Wadsworth, Ohio
39	1	Feed Check Valve	Fig. 236 3/4"	Ohio Injector Co., Wadsworth, Ohio
40	1	Water Level Electrode Assembly	C-49 & C-50, Bronze	Ames Iron Works, Oswego, N.Y.
41	1	Water Level Relay	Type LM-RH	B/W Controller Co., Birmingham, Mich.
44	1	Feed Pump	Model A35	Aurora Pump Co., Aurora, Ill.
49	1	Oil Solenoid Valve	Type K-10-1 115 Volts	General Controls Co., Glendale, California
49	1	Oil Solenoid Valve (Alternate)	#6831967-3 115 Volts	Detroit Lubricator Co., Detroit, Mich.
55	1	Feed Water Pressure Gauge	2" Fig. 23 0 - 200#	Marshalltown Mfg. Co., Marshalltown, Iowa
56	1	Oil Discharge Pressure Gauge	2" Fig. 23 0 200#	Marshalltown Mfg. Co., Marshalltown, Iowa
61	1	Feed Pump Strainer	3/4" Y Cast Iron	Sarco Strainer Co. Inc., Bethlehem, Pa.
70	1	Injector	1/2" Fig. 247-1 Size AA	Penberthy Injector Co., Detroit, Mich.
71	1	Injector Suction Strainer	1/2" No 377	Penberthy Injector Co., Detroit, Mich.
72	1	Injector Suction Valve	1/2" Fig #527	Ohio Injector Co., Wadsworth, Ohio
73	1	Injector Feed Check Valve	1/2" Fig. #35	Crane Co., Chicago, Ill
74	1	Injector Feed Stop Valve	1/2" Fig. #520	Ohio Injector Co., Wadsworth, Ohio
75	1	Injector Steam Stop Valve	1/2" Fig. #520	Ohio Injector Co., Wadsworth, Ohio
79	1	Control Cabinet	Steel	Ames Iron Works, Oswego, N.Y.
80	1	Steel Base	5" Channels	Ames Iron Works, Oswego, N.Y.
90	1	Feed Water Tank	Steel	Ames Iron Works, Oswego, N.Y.
91	1	Float Control Valve	3/4"-12T	Schade Valve Mfg. Co., Philadelphia, Pa.
92	1	Feed Tank Strainer	3/4"-Y Cast Iron	Sarco Strainer Co., Inc., Bethlehem, Pa.
93	1	Feed Tank Thermometer	1/2" Angle Midget	U.S. Gauge Co., Sellersville, Pa.
94	1	Feed Suction Check	Size 3/4" Fig. 236	Ohio Injector Co., Wadsworth, Ohio
102	1	Feed Water Tank Water Gauge	#3L Size 1/2"	Essex Brass Co., Detroit, Mich.
104	1	Power Switch	Cat. #2227 Type RB	Trumbull Elec. Co., Plainville, Conn.
106	1	Control Cabinet Panel	W98A	Minneapolis-Honeywell, Minneapolis, Minn.
107	1	Spare Parts and Tool Box	Steel	Ames Iron Works, Oswego, N.Y.



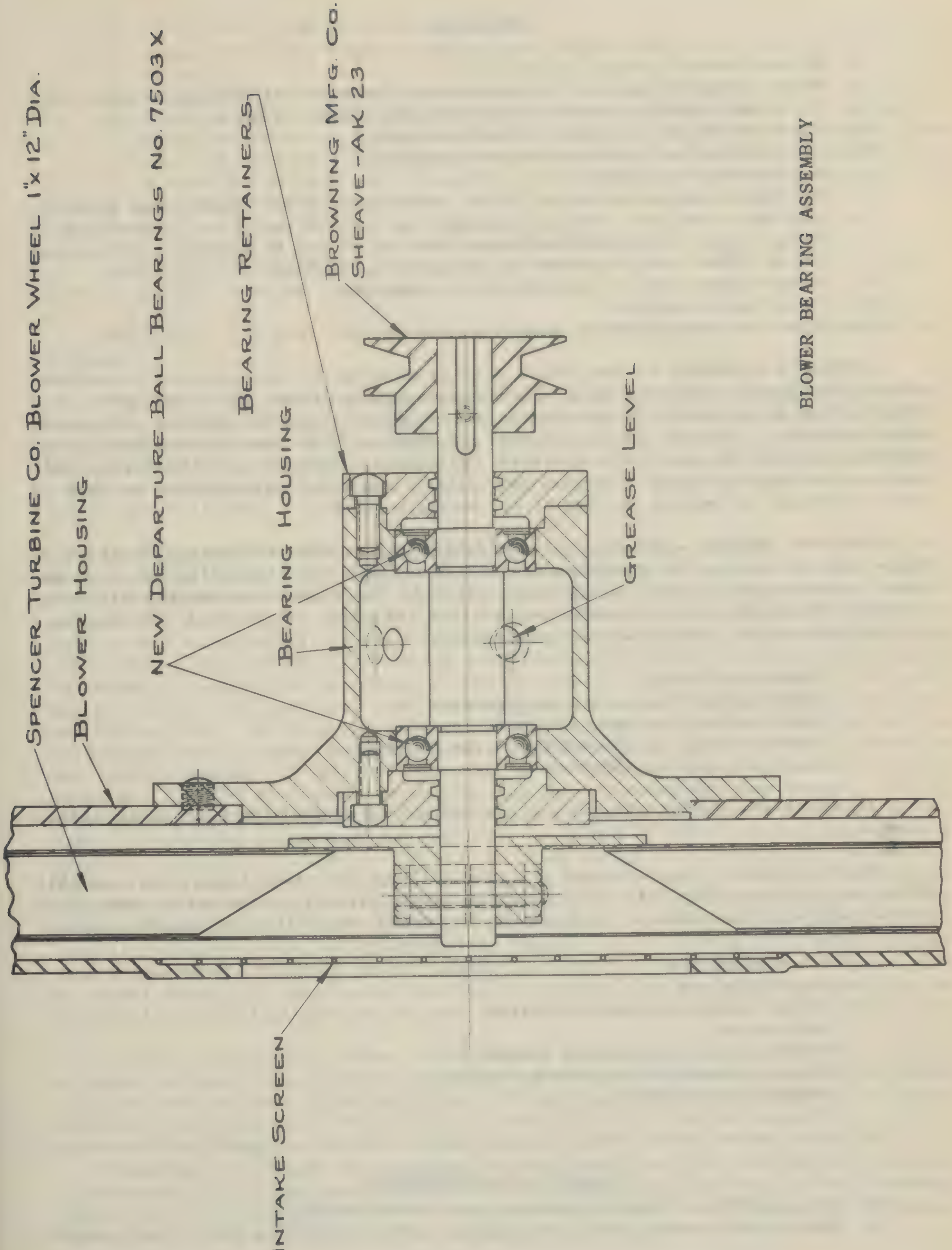
ASSEMBLY AND FOUNDATION PLAN OF
NO. C-12 CYCLOTHERM STEAM GENERATING UNIT
OPERATING PRESSURE 100 LBS.--A.S.M.E. CODE



SECTIONAL VIEWS OF
NO. C-12 CYCLOTHERM STEAM GENERATING UNIT
OPERATING PRESSURE 100 LBS. - A.S.M.E. CODE
U.S. ARMY CONTRACT NO. W2826 MD-1781



WIRING DIAGRAM FOR
NO. C-12 CYCLOTHERM STEAM GENERATOR



BLOWER BEARING ASSEMBLY

OPERATION

1. Be sure there is water in the boiler.
2. Adjust pressure control to approximate maximum boiler pressure desired.
3. See that electric control circuit has proper fuses.
4. Check oil lines to be sure valves are open.
5. See that boiler feed pump has water supply.
6. See that oil is in tank.
7. See that stackswitch relay is in starting position (push reset button).
8. *CAUTION* - See that link arrangement on control panel is in position to conform with power supply voltage. The boiler can be operated, with either 110 or 220 volt A.C. current by changing the linkage.
9. Connect power line to receptacle on switch box.
10. Close burner switch.
11. Press low water reset on water level relay.

AUTOMATIC OPERATION of the entire unit is provided by the controls as outlined above. The burner will start when the pressure switch closes the circuit, due to a drop in boiler pressure. Burner motor, oil pump and electric ignition will start simultaneously. The oil valve will open and flame will be established when oil is sprayed from the nozzle. The electric ignition is continuous. The burner will continue to operate until the pressure switch opens the circuit due to rise in boiler pressure to maximum setting of the pressure switch.

IGNITION FAILURE - Should ignition fail to occur when the burner is started, there will be no rise in stack temperature to actuate the bimetallic strip of the stack safety switch, and a safety warp switch in the combustion control will trip and stop the burner after a predetermined time for which the control has been set. On ignition failure check the following causes.

Transformer dead.
High tension lead broken or grounded.
High tension electrode insulator cracked.
Carbon deposit on electrodes or insulators.
Electrode setting incorrect.

To start the burner after ignition failure depress button on stack safety switch.

FLAME FAILURE - In the event of flame failure the stack temperature quickly drops and the bimetallic helix will open the burner circuit in the safety combustion control and stop the burner. On flame failure check the following possible causes:

Out of fuel oil.
Nozzle clogged.
Suction line or strainer clogged.
Belt broken.
Pressure regulator spring broken.
Pressure regulator diaphragm broken.
Solenoid valve dead.

To start burner after flame failure depress button on stack safety switch.

CARE AND MAINTENANCE

1. Grease motor and blower bearings every three months.
2. Remove rear cover and clean boiler tubes with flue brush each month.

3. Clean fuel pump strainer each month.
4. Clean boiler feed pump strainer each month or more often if feed water is dirty.
5. Clean bimetal of stack safety switch every six months.
6. Inspect blower drive belt periodically and adjust tension if necessary.
7. When the boiler is to be out of service for a long period, the boiler head and tube surfaces that come in contact with the products of combustion should be given a coat of grease, red lead, black japan or tar paint to prevent external corrosion. Fill the boiler with water.

BOILER FEED PUMP C-12

OPERATING INSTRUCTIONS - *It is very important that these instructions be both carefully read and followed.*

ROTATION - The pump must be run in direction indicated by the arrow on the casing.

STARTING - Fill the pump with water (this is called priming). Before starting pump, the casing and suction pipe must be completely filled with water, for unless this is done the pump will not operate, as air will be pumped instead of water. Pumps can be primed in three ways: 1st - by filling casing and suction pipe with water and holding water with foot valve; 2nd - with vacuum pump; 3rd - with steam, air or water ejector.

LOCATING REASONS FOR FAULTY OPERATION - In operating a pump, that which may seem to be serious trouble may arise, but close and careful inspection will usually reveal the fault to be (1) if no water is being delivered (a) pump may not be primed; (b) speed may be too low; (c) discharge head too high; (d) suction lift too high, check with gauges; (e) that the impeller is completely plugged up; (f) the impeller may be rotating in the wrong direction. (2) If not enough water is being delivered (a) air leaks may exist in the suction or the stuffing boxes; (b) speed may be too low; (c) discharge head may be higher than anticipated; (d) suction lift may be too high; (e) impeller may be partially plugged up; (f) there may not be sufficient suction head for hot water; (g) wearing rings may be worn; (h) impeller may become damaged; (i) the foot valve may be too small; (j) casing packing might be defective; (k) the foot valve or suction opening not submerged deep enough. (3) If there is not enough pressure (a) speed may be too low; (b) there may be air in the water; (c) wearing rings worn; (d) impeller damaged; (e) casing packing defective or impeller diameter too small. (4) If the pump works for a while and then loses suction (a) there may be a leak in the suction line; (b) water seal may be plugged (c) suction lift too great; (d) air or gas may be found in the liquid. (5) The pump may take too much power (a) speed is too high or (b) the head is different than that for which pump was selected; (c) the liquid may be heavier than water in this case viscosity and specific gravity should be checked or (d) mechanical defects such as a bent shaft; (e) rotating element may be binding, because stuffing boxes may be too tight, or wearing rings may be worn or finally casing packing may be devective.

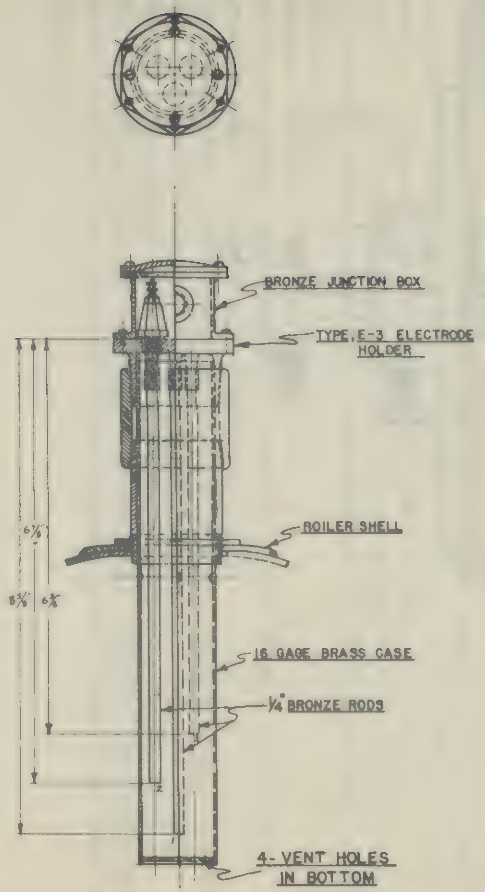
If the speed is too low on a unit direct connected to either electric motors or steam turbine, investigation should be made to determine whether motor is across the line and whether it is receiving full voltage; or in the case of the steam turbine, make sure that the turbine is receiving full steam pressure.

BEARINGS - It would be impossible to over-emphasize the importance of proper lubrication of ball bearings in pumps. It is recommended that regular ball bearing grease should be used when available and suggested kinds are Standard Oil Company, Superla #18 or equal, otherwise any standard vaseline can be substituted.

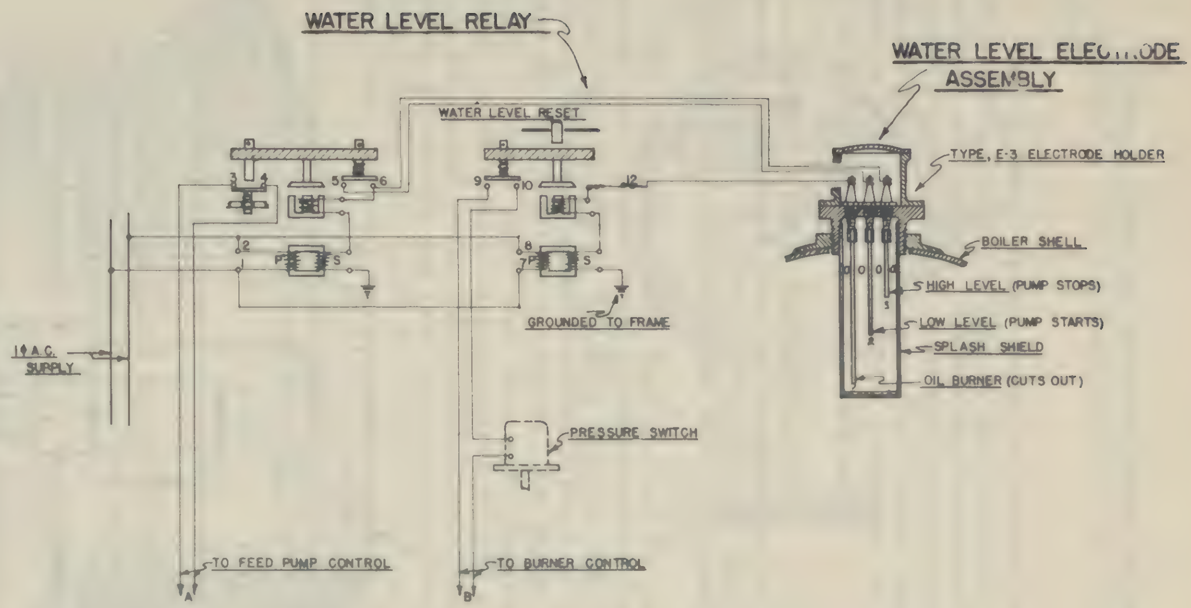
LIST OF SPARE PARTS AND TOOLS
FOR
CYCLOTHERM STEAM GENERATOR NO. C-12
U. S. ARMY CONTRACT W2826-MD-1781

ITEM NO.	NO. OF SETS	NO. PER SET	NAME OF PART OR TOOL	MANUFACTURER'S DATA CATALOG OR SERIAL ORDERING DATA	UNIT SALES PRICE FOB OSWEGO
1	3	1	Water Gauge Glass	5/8" x 7¼"	.25
2	3	2	Water Gauge Glass Gaskets	5/8"	.05
3	1	4	Clean Out Plugs	1¼" Sq. Hd.	.75
4	1	1	Asbestos Packing	5' (5/8"O 1½' (3/8")	2.25
4A	1	1	Burner Head Gasket	R4651 7½" ID-9½"OD	.25
			For Mechanical Auxiliaries		
5	1	1	V-Belt	Type #1340	.70
6	2	1	Oil Burner Nozzle Complete	4 Gal. – 45°	1.70
7	1	1	Fuel Pump Complete	Type 1T-A3101	19.15
8	1	1	Fuel Pump Strainer Assemblies	A33T7	1.95
9	1	1	Fuel Pump Coupling	1A-070- 1/2" x 5/16"	1.35
10	1	2	Blower Bearings	7503X	Set 1.50
11	1	2	Oil Supply & Return Tubing & Connections	5/16" x 8'-0"	1.40
			For Condensate Tank		
12	3	1	Water Gauge Glass	5/8" x 7"	.25
13	3	2	Water Gauge Glass Gaskets	5/8"	.05
14	1	1	Feed Pump Coupling Chain	(For 3AA Coupling)	1.90
			For Electrical Auxiliaries		
15	1	2	Ignition Electrodes	Type STT-38	Set 2.60
16	1	2	Ignition Cables and Connectors	7MM Cable-#214 Ter.	Set 3.30
17	1	1	Ignition Transformer	Type 311-AEF	10.40
18	1	2	Bearings for Burner Motor	#87504	Set 8.75
19	1	2	Bearings for Feed Pump Motor	#87504	Set 8.75
			Tools and Wrenches		
20	1	3	Allen Set Screw Wrenches		
			For Fuel Pump	1/4"	.10
			For Fuel Pump Coupling	5/16"	.10
			For Feed Pump	1/4"	.10
21	1	1	Clean Out Plug Wrench	Williams 271-X	2.40
22	1	1	Tube Brush Close Nipple & Handle	2" Fig. 580 Brush only	1.50
23	1	1	Wrench and Packing for Injector	AA	.25

MANUFACTURER AMES IRON WORKS OSWEGO, NEW YORK	*When reordering always refer to A.I.W. Order No. 69154*



WATER LEVEL ELECTRODE ASSEMBLY

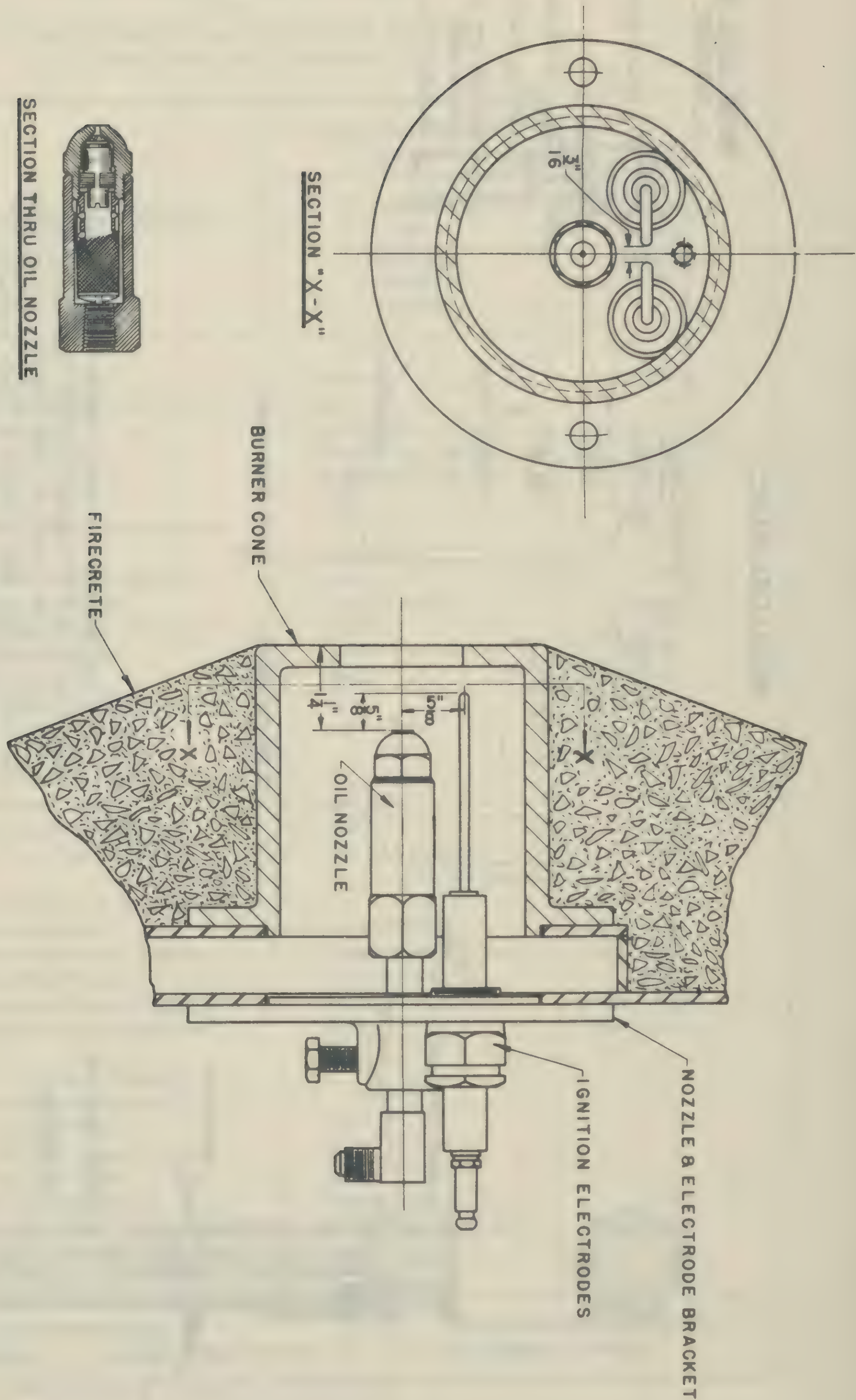


OPERATION—:-

RELAY AND TRANSFORMER SECONDARILY CONNECTE HROUGH ELECTRODES AT VARIOUS LEVELS TO CONTACT LIQUID SURFACE ACTUATES OPENING AND CLOSING OF ELECTRIC CONTACTS. PUMP CONTROL RELAY CLOSES AT LIQUID CONTACT OF UPPER ELECTRODE, REMAINS CLOSED UNTIL LIQUID RECEEDS FROM MIDDLE ELECTRODE, THEN REMAINS OPEN UNTIL LIQUID SURFACE AGAIN IS RAISED TO UPPER ELECTRODE.

BURNER CONTROL CONTACTS OPEN WHEN LIQUID LEVEL RECEEDS FROM LOWER ELECTRODE BURNER THEN WILL NOT OPERATE UNTIL LIQUID LEVEL HAS BEEN RESTORED AND RELAY RESET.

LOW WATER CUTOFF AND PUMP CONTROL FOR CYCLOTHERM STEAM GENERATOR



NOZZLE & ELECTRODE ASSEMBLY FOR CYCLOTHERM STEAM GENERATING BOILER

Heating of bearings invariably means too much grease instead of an insufficiency and careful inspection to determine the trouble should be made before grease is added.

At the end of three months of service, housing should be opened and flushed with clean gasoline or kerosene and new grease applied. Great care should be exercised to keep housing immaculately clean and only clean grease should be used for lubricating bearings. Under no circumstances should grease which has been used before be used. Foreign solids or liquids invading housing can completely ruin the bearings in a short time. It is important to use clean instrument and cloths when cleaning housing and greasing bearings.

PACKING - Pumps leaving our plant are packed and lubricated ready for use. However, when a pump is to be repacked the following procedure, as herein outlined, must be rigidly followed. The packing used for clear cold water is long fibre asbestos, square braided, and well impregnated with oils and graphite.

After the glands have been removed the packing, cut to proper length and compressed just enough to slide readily without being smashed while placing, is inserted into stuffing box. Pressure with the hand and fingers should be sufficient for pushing the rows of packing into place. If it is not, either the packing is too large or some obstruction exists. The rings are placed so that splices are staggered. If water seal rings are used, they are placed in line with the water seal tubing, which usually means symmetrically in regard to packing rings. If number of rings is uneven, extra ring is placed on outside of water seal. After all rings are placed, glands are put into position and inserted into stuffing box tight enough to permit just a few drops of water to drip out per minute. This slight amount of water helps lubricate the pump shaft at the packing joints.

INSTRUCTIONS FOR DIASSSEMBLY OF SINGLE IMPELLER PUMPS - *Follow operations in order given below and refer to cross section drawing form No. 11-CS-129 for part numbers.*

Read Instructions entirely through before starting to disassemble.

1. Remove cover plate cap screws No. 19A.
2. Loosen adjusting nut set screws No. 29.
3. Remove adjusting nut No. 25.
4. Remove jam nut No. 24 - Requires socket type wrench.
5. Loosen packing gland eyebolts No. 18A and swing clear of gland No. 17A.
6. Cover plate No. 22 can now be removed - should it stick, tap lightly around flanged edge to loosen or drive flat edged tool (screw driver or chisel) between flanges of cover plate and pump shell at several points around shell. (Be careful or you will break flanges.)
7. Loosen ball bearing lock collar set screw No. 42. Hold lock collar No. 39 with pipe wrench and turn pump shaft with coupling until lock collar loosens up.
8. Loosen coupling set screw No. 4.
9. Pull out shaft and impeller together just enough to remove pump half coupling No. 2 and woodruff key No. 3.
10. Now pull shaft and impeller clear of pump. Impeller can be removed from shaft by loosening set screws No. 10A.
11. Remove cover plate No. 15 by first removing cap screws No. 19.
12. Ball bearings can be removed from bearing arms by pushing same outward from stuffing box side of cover plates after adjusting nuts have been removed.

INSTRUCTIONS FOR REASSEMBLY OF SINGLE IMPELLER TYPE PUMPS - Just reverse operations as given for disassembly.

IMPORTANT - Extreme care should be taken to make sure that all inner surfaces of pump shell No. 8 are absolutely free from scale, dirt and burns. This also applies to cover plate surfaces and in fact, to all surfaces, otherwise the parts will not fit properly and trouble will be encountered in the assembly. Precaution at the start will save time and insure against difficulty. Wash all parts carefully in gasoline.

Make sure Liquid Slingers No. 16 are placed on shaft when reassembling. These slingers prevent the possibility of any liquid, which may leak from the stuffing boxes, from entering the ball bearing and washing out the grease.

Check up on packing in stuffing box. It may have become dried out and hard. If so, renew it with a good grade of braided, graphited and lubricated asbestos packing. Do not pull up too tight on packing glands No. 17 & 17A. Let the pump run in and *always tighten* packing glands when pump is running and then just enough to prevent excessive leakage. A drip of a few drops per minute is highly desirable as this keeps packing from drying out and prevents scoring of pump shaft.

INSTRUCTIONS FOR ADJUSTING IMPELLER CLEARANCE (AFTER ASSEMBLY)

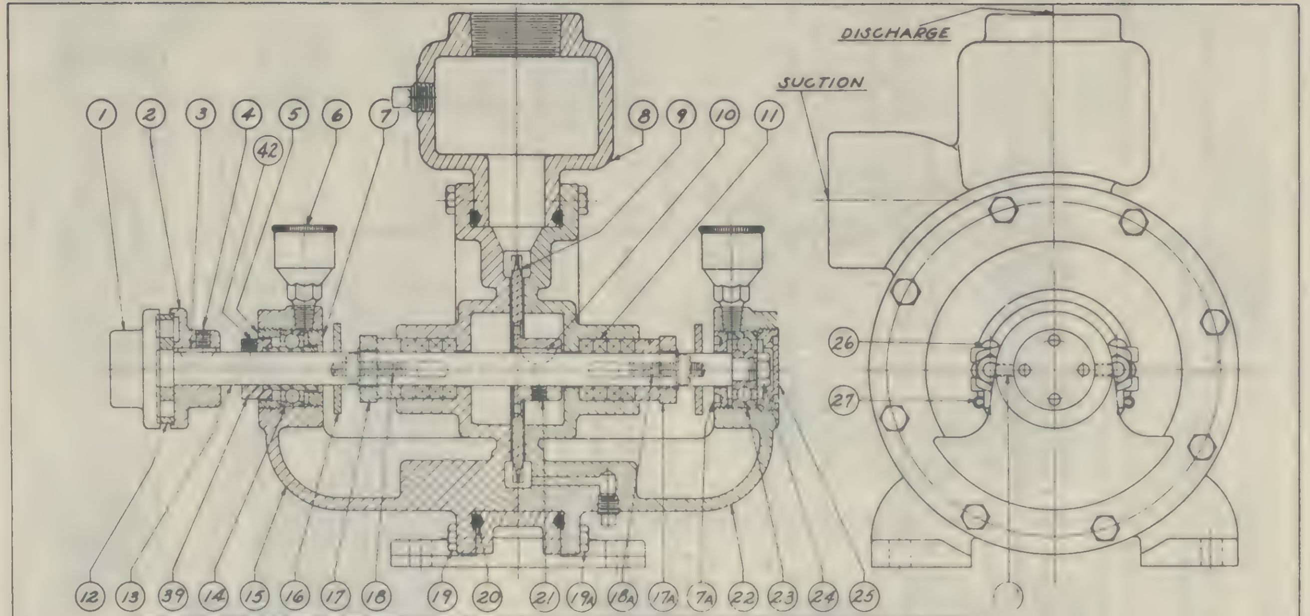
1. Screw in adjusting nut No. 25 partially. Make sure both adjusting nuts Nos. 25 and 7A are loose before starting the adjustment. Leave adjusting Nos. 5 & 7 slightly loose.
2. Tighten adjusting nut No. 25 sufficiently that shaft will not turn (to try this take hold of coupling and try to rotate). The impeller is now rubbing against cover plate on coupling side of pump.
3. Loosen adjusting nut No. 25 just a fraction of turn or until you can rotate shaft freely. Now tighten up on adjusting nut No. 7A and try to rotate again. If pump turns over freely with no indication of impeller rubbing, the pump is properly adjusted. If rubbing still occurs you can work the two adjusting nuts "back and forth" until pump does rotate freely. Do not tighten up on adjusting nuts too much, just bring up firmly by very light taps of hammer. After proper adjustment has be secured, then lock adjusting nuts by tightening up the adjusting nuts set screws No. 29, located in the bearing arms.
4. It is recommended that impeller adjustment be made with packing removed from pump.

SPECIAL NOTE - When pumping hot liquids, should pump fail to rotate freely due to excessive expansion of casing and shaft, loosen adjusting nuts No. 25 and No. 7A. Now readjust as per preceding instructions at operating temperature.

TO ADJUST AND ALIGN FLEXIBLE COUPLING - Before tightening up coupling set screw No. 4, locate pump half coupling No. 2, by sliding shaft, so that coupling pins or lugs on pump half coupling does not strike motor half coupling. Leave at least 1/16" clearance. Be sure coupling insert No. 12 is in place.

After complete assembly of pump and motor on base plate, be sure to "line-up" coupling. Failure to do this will cause insert to wear out; also a rumbling noise will be present when pump is running. "Lining up" can easily be checked by applying a straight edge across the coupling, which must reset evenly on both rims at the top, bottom and sides. Then shims should be placed under pump or motor if necessary to accomplish perfect alignment. See Instructions under heading "Alignment" appearing in *Installation* and *Operating Instructions*.

BOILER FEED PUMP



NO	PART	NO	PART	NO	PART
1	COUPLING MOTOR HALF	11	PACKING	21	SETSCREW
2	COUPLING PUMP HALF	12	COUPLING INSERT	22	COVER (RIGHT)
3	COUPLING KEY	13	SHAFT	23	BALL BEARING
4	SETSCREW	14	BALL BEARING	24	JAM NUT
5	ADJUSTING NUT	15	COVER (LEFT)	25	ADJUSTING NUT
6	GREASE CUP	16	WATER SLINGER	26	CLEVIS PIN
7	ADJUSTING NUT	17	GLAND	27	COTTER PIN
8	SHELL	18	EYEBOLT, NUT+WASHER	39	LOCK COLLAR
9	IMPELLER	19	CAPSCREW	29	SETSCREW
10	IMPELLER KEY	20	GASKET	42	LOCK COLLAR SETSCREW

TYPE "S" APCO
SCALE. DRAWN BY:
DATE. 1-16-40 11-CS-129

HOW TO ORDER REPAIR PARTS - Order by part name and part number; also give size and serial number of pump found on name plate. It is absolutely necessary to give serial number in order that we can identify the particular model pump for which repairs are wanted.

GENERAL CONTROLS INSTRUCTION SHEET FOR MAGNETIC VALVE K-10-1, 2, 5, 6, 10, 12

INSTALLATION - Valve must be installed in a horizontal pipe line with solenoid above the line and in a vertical position.

Do not use solenoid case as a means to screw valve on or off line.

When valve cage nut is removed or tightened do not use solenoid to hold valve but use wrench on body hex.

The *BEST ENGINEERING DESIGN* of this valve requires the plunger tube to be as light as possible - hence avoid *STRAIN* at any time.

CLEANING - K-10-Valves may be removed from pipe line and taken apart for cleaning as shown in drawings below.

If installed in rigid conduit, remove screw in top of terminal cover and lift up, solenoid may then be removed by unscrewing nut as shown in figure 1 and valve more easily unscrewed from pipe line.

Pull out entire valve cage and plunger assembly as shown in figure 2. A screw driver may be inserted under lever arm through back end of valve and tapped with palm of hand to loosen. Do not force lever assembly through end with pliers:

When valve cage assembly has been taken out as shown in figure 3, raise lever arm to depress valve spring and raise needle off of seat - Clean out with small stiff brush using kerosene or other suitable solvent.

Do not unscrew valve seat, but see that same is tight, valve will leak if this valve seat is not screwed up tight.

Hold unit up to light and if needle or seat appears pitted or otherwise damaged replace with entire new valve cage assembly.

Be sure that all valve gaskets are in good condition and properly replaced when reassembling a valve.

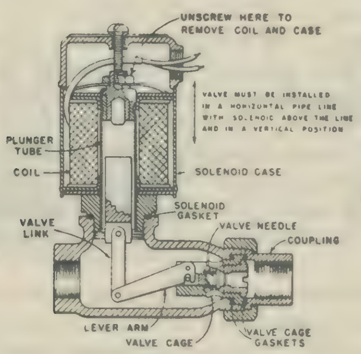


Figure 1

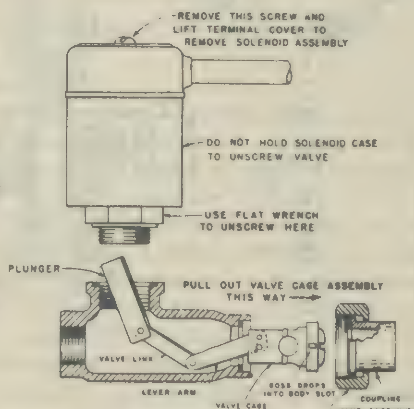
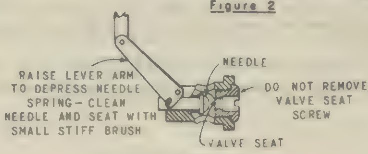


Figure 2

CAUTION: Do not remove valve seat, or try to take out needle. This entire unit is assembled and adjusted at the factory. If found to be defective replace with entire new valve cage assembly



VALVE CAGE ASSEMBLY
Figure 3

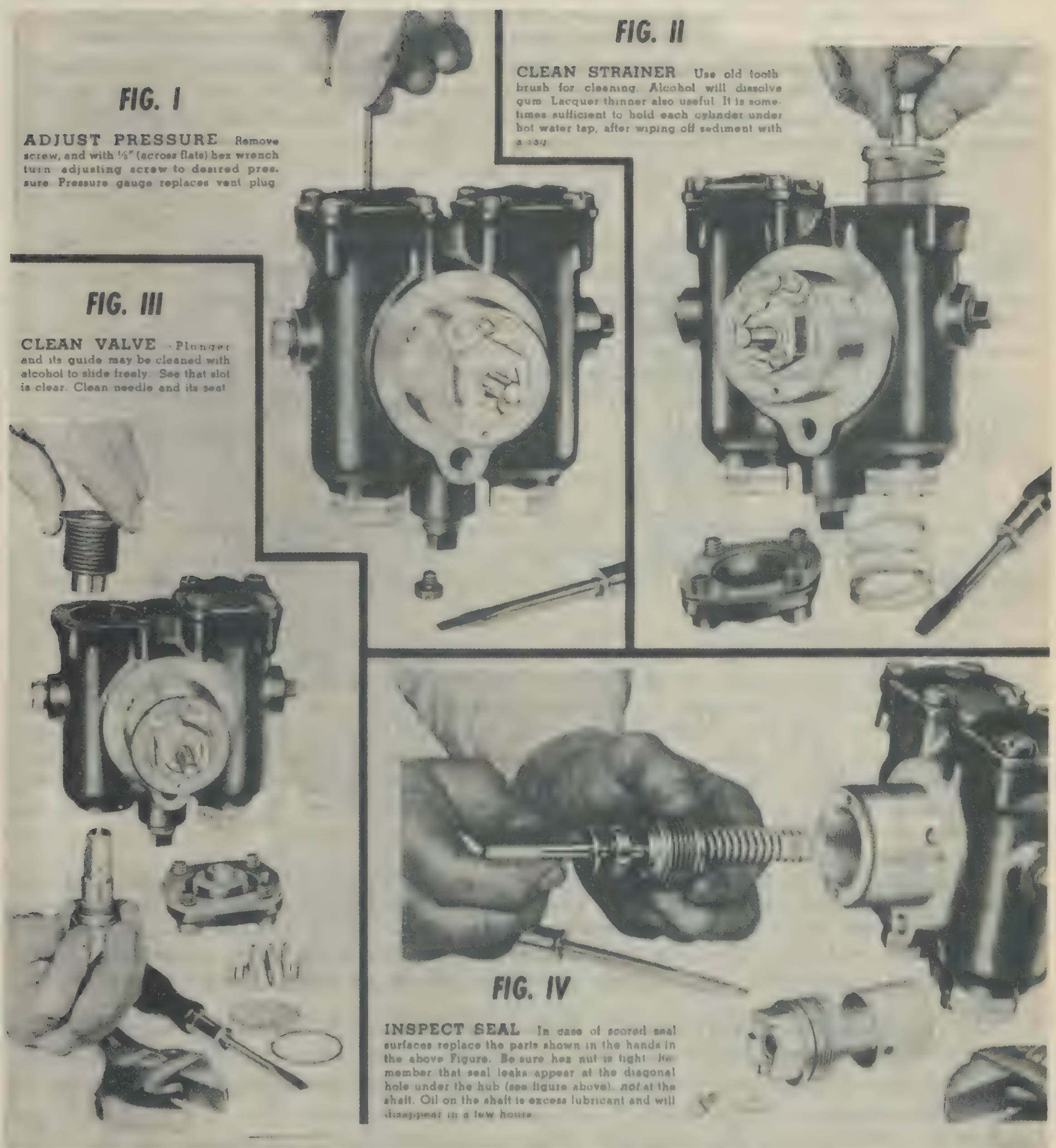


FIG. I

ADJUST PRESSURE Remove screw, and with ⅛" (across flats) hex wrench turn adjusting screw to desired pressure. Pressure gauge replaces vent plug.

FIG. II

CLEAN STRAINER Use old tooth brush for cleaning. Alcohol will dissolve gum. Lacquer thinner also useful. It is sometimes sufficient to hold each cylinder under hot water tap, after wiping off sediment with a rag.

FIG. III

CLEAN VALVE Plunger and its guide may be cleaned with alcohol to slide freely. See that slot is clear. Clean needle and its seat.

FIG. IV

INSPECT SEAL In case of scored seal surfaces replace the parts shown in the hands in the above Figure. Be sure hex nut is tight. Remember that seal leaks appear at the diagonal hole under the hub (see figure above), *not* at the shaft. Oil on the shaft is excess lubricant and will disappear in a few hours.

SERVICE BULLETIN WEBSTER TYPE "T" FUEL UNIT 300 SERIES

The Webster Type "T" Two-Stage Fuel Unit is successor to the pioneer Type "D" Two-Stage Unit. This unique device has been designed primarily for use on outside tank jobs using a two-pipe system, and under severe conditions absolute self-priming, continuous venting, and freedom from "tank-hum" are assured. It is just as effective, of course, on two-pipe inside tank jobs.

This unit may be received by you arranged either for a single or a two-pipe system. It is easy to determine which simply by looking at the strainer cover. If the cover is in the position shown in figure I, the unit is arranged for a single-pipe system, i.e., no return line, and the center port in the bottom of the unit marked "Bypass" is plugged. If on the other hand, the cover is as shown in figure II, then a return line is necessary.

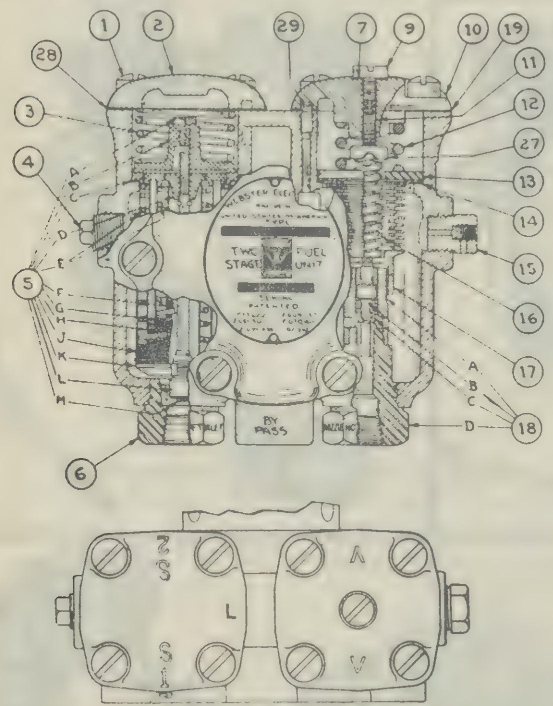


FIGURE I

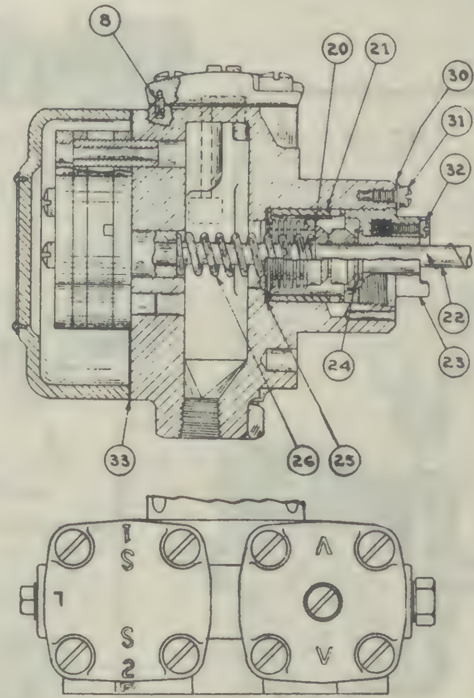


FIGURE II

To change from single-pipe to two-pipe system or vice-versa, proceed as follows: Remove the strainer cover (2) by taking out four screws (1). On the under side of the cover will be found a locating screw (8). For a single-pipe system this locating screw will be under the cast figure "1" and for a two-pipe system the locating screw will be in the tapped hole opposite, which is under the cast figure "2".

In replacing the cover, the "1" cast on the top combined with the "P" cast on the body indicates "one-pipe" as shown in figure I, and when the cover is reversed, the "2" on the cover and the same "P" on the body indicate "two-pipe" as shown in Figure II.

Venting is necessary only when the unit is used in a single-pipe system. When venting is necessary, loosen the screw in the vent plug (15), located on the side of the regulating valve chamber. With the fuel unit in operation, allow enough oil to drain out to purge the entire system of air.

Remove plug (4) and install vacuum gauge when vacuum is to be checked.

Replace vent plug (15) with pressure gauge when adjusting the pressure. To adjust pressure, remove the cover screw (9) and with an Allen wrench 1/8" across flats turn the adjusting screw (11) clockwise (down) to increase pressure, and counterclockwise (up) to decrease pressure. Be sure to replace the cover screw (9) and gasket (7).

We believe that no pump should be arranged for single-pipe system when there is a chance of a suction lift, but if such is the case do *not* adjust the pressure while the unit is running, as air will be sucked in past the adjusting screw. Make a trial adjustment, *replace the cover screw* (9), start the burner, and if further adjustment is necessary, try again. This method will take less time in the end, and give better results.

STRAINER - To clean the strainer, loosen the four screws (1) remove strainer chamber cover (2) and holding spring (3). The entire strainer assembly (5) can then be lifted out with thumb and forefinger, and disassembled by unscrewing knurled nut (5L). Each screen 5F, G, H, J can be cleaned inside and out with a suitable brush. Alcohol will dissolve most gum deposits and other dirt can be loosened with lacquer thinner. The use of very hot water at high velocity is also effective. When replacing strainer in the pump body, be sure that the shoulder on which the strainer top plate (5D) rests is clean and gasket 5C is in place. Replace holding spring (3), strainer chamber cover (2), and gasket (28), then tighten screws (1) evenly and firmly, using a screw driver which fits and is in good condition.

VALVE - Improper valve action can be caused by scored or gummy parts, and dirt on the valve seat or in the "leak pin" (29) groove, but usually poor or late cut-off is due to unpurged air in the nozzle line and nozzle body, especially during the first day or two of operation.

The valve is easily serviced by means of removing its two main assemblies. To inspect the valve bellows assembly, loosen the four valve chamber cover screws which permits the removal of the valve chamber cover (10). Remove holding spring (12), washer (13), adjusting spring (16), cap (27), and bellows assembly (17). By means of a wrench that fits well on the hex marked "Nozzle" (18D) (1 1/16 across flats) remove the needle valve and plug assembly (18). If necessary, tap the wrench handle with a hammer. Now remove valve guide (18A) (9/16 across flats). This exposes the double needle valve, the spring, and the nozzle valve seat. A leaking nozzle is often due to dirt or corrosion at this point. In case a new seat or needle is necessary, the entire assembly (18) should be replaced. In reassembling put the needle valve and plug assembly in first. In reassembling the valve chamber cover, be sure the "leak pin" (29) is in place.

A quick test for valve operation consists in detaching the nozzle line at the pump connection, starting and stopping the pump and observing whether the valve cuts off sharp and clean.

PUMP - The seal can be easily removed for inspection. First, remove the lock plate (30) with a screw driver, then loosen seal cover and bearing assembly (23) which contains the self lubricating outer shaft bearing that is fed from a supply of oil in reservoir. Ordinarily, this oil will last the lifetime of the fuel unit, but an oiling means is provided by the "oil hole cover screw" (32). Carefully remove drive shaft (22) which carries the seal nose. After removal of spaced sleeve (21), the seal bellows assembly (20) can be taken out. Before replacing seal assembly carefully clean all parts, then proceed as follows:

1. See that the seal surface of the seal ring at one end of the bellows is parallel to the brass plate at the other end and the overall distance between them 27/32 of an inch.
2. A good test to make in order to check the above dimension is to assemble the parts 20, 21, 22, 23, and 24 in your hands and in the relative positions shown in the cross section on the other side. *The brass plate should not quite touch the end of the spacer sleeve 21.* One thirty-second of an inch space is about right - it shouldn't be any less, and shouldn't be more than 3/64.
3. Assemble the parts into the pump in the following order: Gasket (25), spring (26) and bellows (20) together, then sleeve (21) with a drill hole *down*, then shaft (22), then thrust washer (24) then the seal cover (23) tightened with reasonable firmness, and finally, the lock plate (30) and the combined screw and lock washer (31).
4. A final check on the seal adjustment would be to press on the end of the shaft to "feel" the slight end movement against the spring pressure.

IMPORTANT - When ordering various service parts, please refer to the numbered list and description of each part below, also giving Fuel Unit *type* and *serial* number which will be found on the name plate.

Any other details regarding Webster Fuel Units should be taken up with your manufacturer.

PARTS FOR TYPE "T" FUEL UNIT 300 SERIES

Effective—Jan. 1, 1940

(Prices subject to change without notice)

Item No.	Part No.	Name	List Price Each
1.	P-8653-P	Valve and Strainer Cover Screws	$0.05
2.	A-2T1 or 2	Strainer Cover	.30
3.	P-26Q11	Strainer Holding Spring	.05
4.	P-6436	Vacuum Gauge Port Plug	.05
5.	A-33T7	Strainer and Silencer Assembly	1.65
(A)	P-35T6	Silencer Screw	.05
(B)	P-27T1	Silencer Body	.20
(C)	P-18Q3	Gasket	.05
(D)	P-20Q3-2	Strainer Top Plate	.15
(E)	P-26T1&2	Strainer Retainer Spring ea.	.05
(F)	P-33T4	Strainer Cylinder	.20
(G)	P-33T3	Strainer Cylinder	.20
(H)	P-33T2	Strainer Cylinder	.30
(J)	P-33T1	Strainer Cylinder	.30
(K)	P-20Q2	Strainer Bottom Plate	.05
(L)	P-10Q1	Strainer Nut	.05
(M)	P-36T4	Strainer Stud	.05
6.	P-37Q1	Strainer Inlet Plug 1/4 P.T.	.55
6.	P-37Q3	Strainer Inlet Plug 3/8 P.T.	.55
7.	P-18Q4	Valve Screw Cover Screw Gasket	.05
8.	P-36Q7	Cover Locating Screw	.05
9.	P-36Q2	Valve Screw Cover Screw	.05
10.	P-2T3-2	Valve Cover	.60
11.	P-8659-1	Valve Adjusting Screw	.10

Item No.	Part No.	Name	List Price Each
12.	P-26Q3	Valve Holding Spring	$0.15
13.	P-31Q2	Valve Holding Spring Washer	.05
14.	P-18Q3	Valve Bellows Gasket	.05
15.	A-37Q6	Vent Plug and Screw Assembly	.15
16.	P-26Q4	Valve Adjusting Spring	.15
17.	B-4Q7	Valve Bellows Assembly	1.05
18.	A-37T4	Needle Valve and Plug Assembly 1/8 P. T.	1.45
18.	A-37T5	Needle Valve and Plug Assembly 1/4 P. T.	1.45
19.	P-18Q12	Valve Cover Gasket	.05
20.	A-30Q4-1	Seal Bellows Assembly	1.60
21.	P-24Q5	Seal Cover Spacer	.50
22.	A-5T	Drive Shaft Assembly	1.20
23.	A-32Q3	Seal Cover and Bearing Assembly	1.20
24.	P-31Q1-1	Thrust Washer	.10
25.	P-18Q1	Seal Bellows Gasket	.05
26.	P-26Q1	Seal Spring	.10
27.	P-12Q1	Valve Spring Cap	.05
28.	P-18T3	Strainer Cover Gasket	.05
29.	P-59Q	Leak Pin	.10
30.	P-65Q1	Lock Plate	.05
31.	P-9568	Lock Plate Screw	.05
32.	P-6976	Oil Hole Cover Screw	.05
33.	P-18T1	Front Cover Gasket	.05

Price on any type of Mounting, Flange or Foot $0.90

BE SURE TO GIVE TYPE AND SERIAL NUMBER STAMPED ON NAME-PLATE

INSTALLATION INSTRUCTIONS

TYPE RA116A PROTECTORELAY

This Protectorelay is designed primarily for stack mounting and will operate quickly and reliably in low stack temperatures. It is normally installed in a horizontal position, but can be mounted at an angle if necessary. The new type bimetal element imparts straightline action to the simplified Pyrostat mechanism. The terminal block and conduit spuds facilitate wiring.

Failure of the burner to ignite and properly maintain combustion will cause the safety switch to trip and shut down the burner preventing any abnormal discharge of oil. The Protectorelay will "lock out" necessitating manual reset before the burner may again be started. The safety switch is compensated for varying basement temperature and its timing is unaffected by varying motor loads since the heating element of the safety switch is in series with the relay coil.

The Protectorelay recycles on power or flame failure and is for use on constant ignition burners.

SPECIFICATIONS

TYPE - RA116A for constant ignition oil burners.

VOLTAGE AND FREQUENCY - 115 volts, 60 cycle standard. Other A. C. voltages and frequencies at extra cost. For D. C. specify R416A Lockswitch and T45A Thermostat.

ELECTRICAL RATING - 1/2 H. P. A. C.

IGNITION RATING - 3 amps. @ 115 volts.

SAFETY SWITCH TIMING - Approximately 90 seconds.

ELEMENT INSERTION LENGTH - With ventilating slots covered) - Adjustable, 2 1/2" to 6 1/2" standard. Special insertion lengths available; 2 1/2" to 9" at no extra cost, 2 1/2" to 10 1/2" at extra cost.

CASE DIMENSIONS - Height 5 5/8", width 6 1/8", depth 3 1/4".

HEATERS THAT MUST BE USED IN HEAT ACCELERATED THERMOSTATS FOR THIS PROTECTORELAY

	115, 230 Volts 50, 60 Cycle	115, 230 Volts 25 Cycle
T11A, T109A, T111A, T178A	Green Coded Heater	Black & Green Coded Heater
T105A	Black & Green Coded Heater	Blue & Brown Coded Heater

WHEN ORDERING SPECIFY -
1. Type Number.
2. Voltage and frequency.
3. Special insertion length, if required.

INSTALLATION - If special mounting provisions are supplied by the furnace, boiler or burner manufacturer follow their recommendations carefully. Where no special instructions are furnished proceed as follows:

LOCATION IN STACK - Select a location for the Protectorelay in the stack as near as possible to the boiler or furnace. The bimetal element should be in the direct path of the hot stack gases. However, the element *must not* be located where its temperature will exceed 1000° F. - and if a draft regulator is used, the location

of the Protectorelay must always be between it and the furnace or boiler. (See Fig. 1). The Protectorelay should preferably be installed with the element tube horizontal. (See "SPECIAL APPLICATIONS" - next page).

MOUNTING - At the proper location drill a 1 3/8" hole. Then, using the mounting bracket as a template, mark the location of the mounting screw holes.

Drill the holes and securely fasten the bracket to the stack with the screws furnished.

Slide the protecting tube into the stack until the bimetal element is in the center. (See Fig. 2). It is important that the element be located in the center of the stack in order that it will be in the direct path of the hot flue gases.

If the Protectorelay is to be mounted in an elbow it is very important to locate the element so that it is positioned not farther into the stack than the center of the elbow. In fact a location farther toward the outside of the elbow is preferable since that is the hottest part of the gas flow.

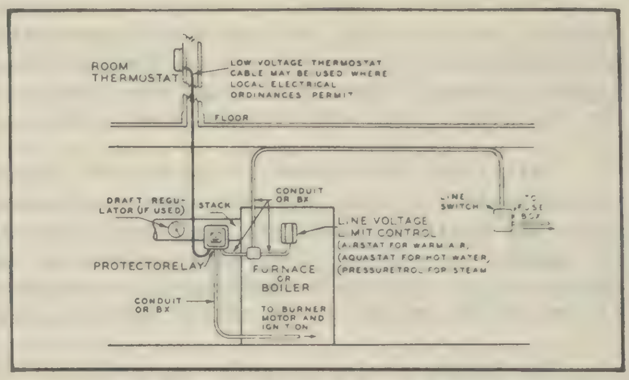


Fig. 1—Typical installation diagram.

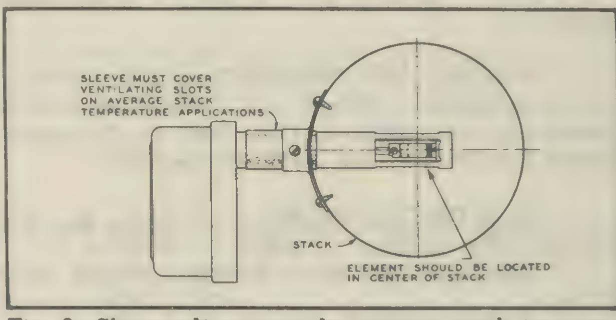


Fig. 2—Sleeve adjustment for average stack temperatures, (ventilating slots completely covered).

It will be noted that the protecting tube is equipped with a movable sleeve covering the ventilating slots in the tube. If an average stack temperature is expected, be sure the ventilating slots are covered by the sleeve. (See Fig. 2). Then tighten the lock screw in the mounting bracket.

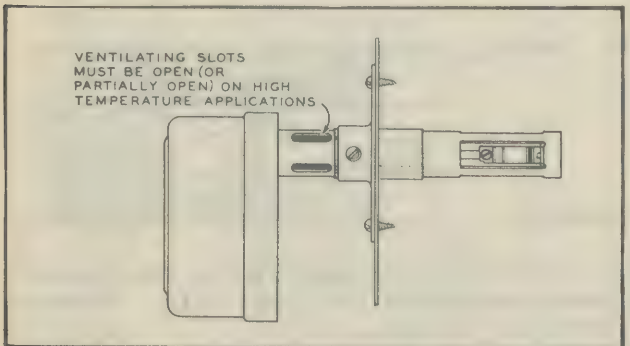


Fig. 3—Sleeve adjustment for high temperature applications, (ventilating slots partially or completely open).

NOTE: - In a few stack mounted applications where unusually high stack temperatures are encountered, it may be necessary to open or partially open the ventilating slots in the tube to safeguard the element. To open ventilating slots loosen bracket lock screw and slide sleeve away from case. Be sure that mounting bracket does not cover slots. (See Fig. 3). Then retighten bracket lock screw.

SPECIAL APPLICATIONS - On some heating plants it may be feasible (or necessary) to locate the bimetal element in or adjacent to the combustion chamber. Reasonable temperature tests of the element and the effects of radiant energy should be carefully determined on these applications.

The ventilating slots in the tube should be opened to cool the element and some form of shield to protect the element from radiant heat should be provided. These measures will prolong the life of the element. To open ventilating slots, slide sleeve away from case - be sure mounting bracket does not cover slots.

Our services are invited when making original applications of this kind.

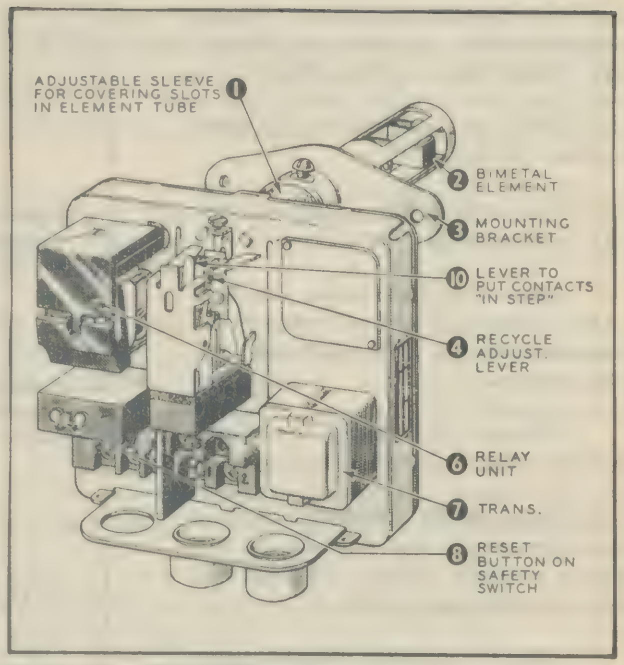


Fig. 4—Type RA116A Protectorelay with cover removed.

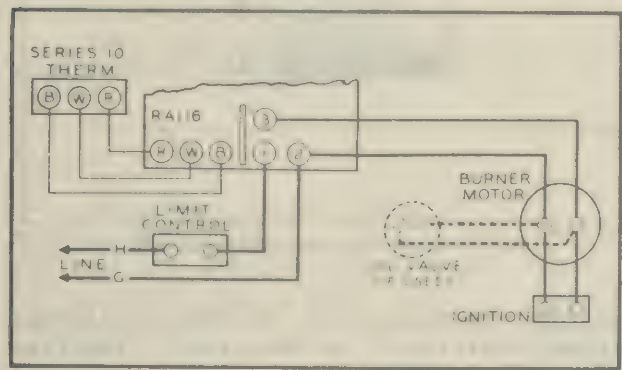


Fig. 5—Connection diagram.

WIRING - *Important: All wiring must be done in accordance with local electrical ordinances.* Use No. 14 rubber covered wire for all line voltage wiring. Flexible cable, if used should have enough slack to permit removal of the Protectorelay for servicing. Standard thermostat cable may be used between the thermostat and the Protectorelay where local codes permit. We recommend placing the high limit control in the "hot" line to terminal No. 1 as shown. However, it may be connected in the low voltage white wire to the thermostat.

TESTING AND ADJUSTING - It is very important that the Protectorelay be tested and adjusted in actual operation.

ADJUSTMENTS FOR AVERAGE STACK TEMPERATURES:

(1) Leave the recycling stop lever at the factory setting - "inward (minimum) position". (See Fig. 6).

(2) Be sure that the ventilating slots are covered by the sleeve. (See Fig. 2).

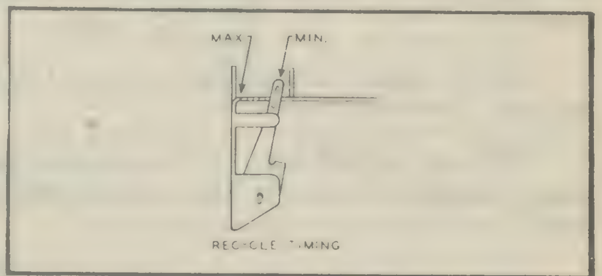


Fig. 6—Factory Setting.

TO START BURNER - Place Protectorelay Contacts in Starting Position. (See Fig. 7).

Depress and release reset button (8-Fib. 4).

Open the hand valve in the oil supply line.

Move the indicator on the high limit control and room thermostat to the high end of the scale.

Close the line switch. Burner should immediately start.

SCAVENGER TIMING - Allow the burner to run and watch the outer clutch finger (3-Fig. 8) as it moves outward.

Clutch finger should move outward until it engages stop arm (2).

The drive shaft (4) should continue to move outward after the clutch finger reaches the stop. This continued movement of the shaft (it need only be a small amount) is very important.

Note - If clutch finger does not engage stop arm (with recycling stop lever (1) set at "minimum" and ventilating slots covered), it indicates that the bimetal element is not getting enough heat to insure proper operation. In this event, the Protectorelay should be moved to a new location where a higher element temperature will be found.

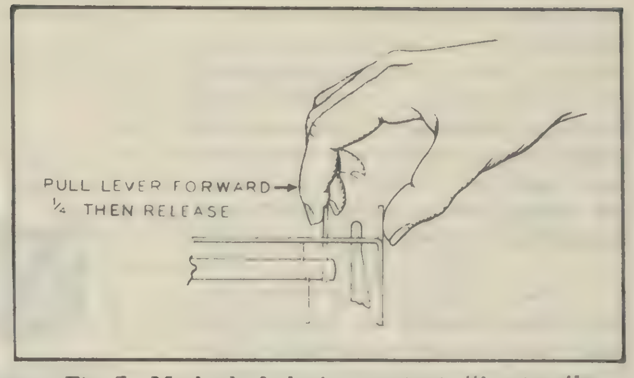


Fig. 7—Method of placing contacts "in step."

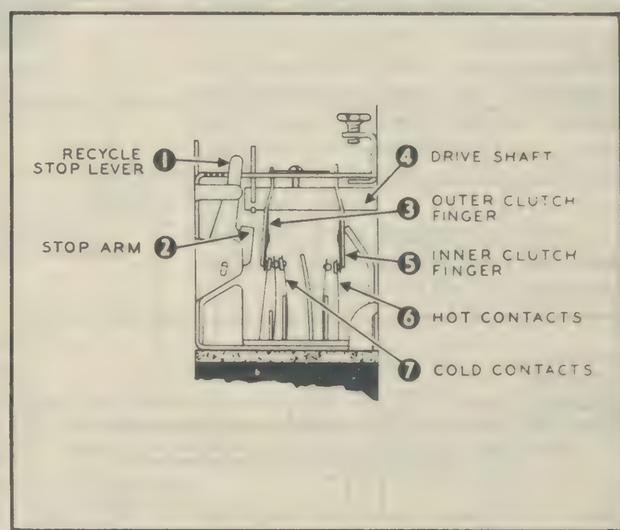


Fig. 8—Recycling time adjustment.

Allow burner to run a few minutes more - then open (and immediately reclose) the line switch, noting the time by your watch as you do so. Burner should stop at once.

Burner should automatically restart (recycle) after this shutdown or scavenger period. Time the restart.

TOO FAST RECYCLING - If the burner restarts too soon (we recommend not less than 1 minute), open the line switch and wait 5 minutes for the heating plant to cool.

Move stop lever (1) *outward* one notch. Then close the line switch. Burner should start immediately.

Watch clutch finger (3) as it moves outward. Clutch finger should move outward until it engages stop arm (2). *The drive shaft (4) should continue to move outward after the clutch finger reaches the stop.* This continued movement of the shaft (it need only be a small amount) is very important. Then open (and immediately reclose) the line switch noting the time by your watch as you do so. Burner should stop at once.

Burner should automatically restart and the time should be noted. If the scavenger period is still too short, repeat tests until a suitable recycling time is obtained. Move stop lever only one notch at a time.

ADJUSTMENTS FOR HIGH TEMPERATURE CONDITIONS - Where high temperatures are encountered (in the neighborhood of 1000° F.), it is recommended that the Protectorelay be installed with the ventilating slots uncovered or partially uncovered. (See Fig. 3). Then check the recycling time as outlined in preceding paragraphs 1 to 9 inclusive.

TO CHECK SAFETY SWITCH - With the burner running, close hand valve in oil supply line. (This would be equivalent to flame failure during normal operation of burner).

When the flame is extinguished hot contacts (6-Fig. 8) should open after a slight drop in stack temperature and stop the burner.

The burner should remain off until the stack cools enough so that the "cold contacts" (7-Fig. 8) make.

When the "cold contacts" make, and the burner motor starts up with the oil supply valve closed, check the timing of the safety switch.

The safety switch should trip and stop the burner motor in approximately 90 seconds at the rated voltage.

OPERATION - (Refer to Fig.9) - When burner is idle, cold contacts "6" and "7" (Fig.9) are closed, hot contact "8" is open, safety switch contact "5" is closed and the relay is "out".

When thermostat calls for heat, relay pulls in, closing contact "22" starting the burner motor and bringing on the ignition. Contacts "9", "10" and "11" are also closed, thereby establishing a holding circuit.

On the initial rise in stack temperature hot contact "8" makes shunting out the safety switch heater. A further rise in stack temperature causes cold contacts "6" and "7" to break. The burner is now in normal operation.

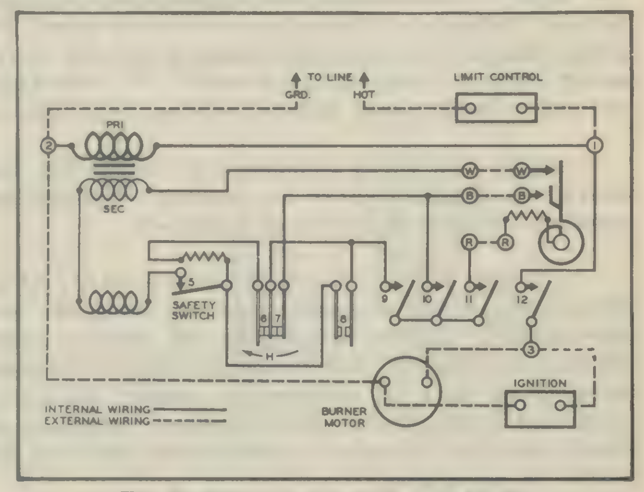


Fig. 9—Schematic circuit of RA116A.

The initial rise in room temperature will open thermostat contact "B". The relay will remain "in" through a holding circuit established through "R" and "W" thermostat contacts and contacts "9" and "11" of the relay. Opening of contact "B" sends all of the current through the thermostat heater thereby causing an accelerated shut-down.

When the thermostat is satisfied contact "W" will open causing the relay to drop out stopping the burner.

IGNITION FAILURE - If combustion fails to take place on startup, hot contact "8" will not make - thus current continues to flow to the safety switch heater and In approximately 90 seconds the safety switch contact "5" will open, stopping burner. The reset button (8-Fig. 4) must then be manually depressed before restart is premitted.

FLAME FAILURE - If a flame failure occurs when burner is running normally, hot contact "8" will open on the inital drop in stack temperature. The relay will immediately drop out stopping the burner. At the expiration of the scavenger period (normally about one minute), cold contacts "6" and "7" will make, restarting the burner. If combustion takes place, burner will continue to run - but if oil fails to ignite, a safety shutdown will occur in approximately 90 seconds. The reset button (8-Fig. 4) must then be manually depressed before burner can restart.

POWER FAILURE - The RA116A Protectorelay automatically recycles in event of power failure.

SERVICE SUGGESTIONS

CAUTION - Do not under any circumstances use oil on this Protectorelay.

It is important that the cover be left on the Protectorelay to protect if from dust and mechanical injury.

If the Protectrelay Fails to Operate after the line switch is closed, and with the high limit control and thermostat calling for heat, depress and release reset button (8-Fig. 4). Burner motor should start immediately. If burner does not start, place the Protectorelay contacts in the starting position - See Fig. 7. Burner motor should immediately start. If combustion does not take place open the line switch. Check power supply, wiring, ignition and oil supply.

NOTE - If it is necessary to place the contacts "in step" (Fig. 7) in order to start the burner, refer to heading "TESTING AND ADJUSTING" and carefully check the complete operating cycle as outlined.

If the burner motor *does not start* when the contacts are placed "in step" (Fig. 7), place a jumper across the red, white and blue terminals of the Protectorelay. If the relay does not pull in (with current "on" and with cold contacts (7-Fig.8) closed), the Protectorelay is defective and should be replaced. If the relay does pull in, remove the jumper and check all connections between the thermostat and Protectorelay and examine the contacts of the thermostat (and low voltage limit control if used) to make sure they are closed. Finally, check the low voltage cable if necessary.

Chattering operation (rapid opening and closing) of the relay indicates an open "red" wire circuit or interchanging of the blue with either the red or white wire somewhere in the low voltage circuit.

If the *Protectorelay Goes on Safety*, after the burner has started up normally, the trouble may be due to any one or more of the following: Down drafts on air leaks in the smoke pipe, slow temperature rise of the flue gas where the Protectorelay element is located, plugged oil line, ignition failure, or accumulation of soot on the bimetal element.

L404F PRESSURETROL - A high limit controller in which variations in pressure cause the bellows to operate a snap-switch which in turn makes or breaks an electrical circuit. Built primarily for steam heating systems but may also be used with air, liquids or gases not chemically injurious. Particularly applicable to mobile units as it is not sensitive to vibration.

SPECIFICATIONS

ADJUSTMENT - External screws. Knurled adjustment knob available at extra cost.

ELECTRICAL RATING - 1 H.P. A.C. 230 volts. 1 H.P. A.C. 115 volts.

RANGE - 5 to 150 Pounds.

DIFFERENTIAL - 8 lbs. adjustable.

MOUNTING MEANS - 1/4" Pipe threads.

CASE DIMENSIONS - Height 3 7/8", Width 5 1/16", Depth 2 1/2".

WHEN ORDERING SPECIFY:
1. Type Number.
2. Knurled adjustment knob is desired.

INSTALLATION

LOCATION - Designed for installing above the water line in steam boilers. May be mounted in the fitting provided by the boiler manufacturer, alongside the pressure gauge, or at a location remote from the boiler.

IMPORTANT - If there is no pressure gauge or fitting to mount in, consult your local boiler representative as to the correct location. The temperature surrounding the switch should never exceed 200° F.

MOUNTING - PROVIDED with a 1/4" iron pipe size female fitting.

When making pipe connections use pipe dope or white lead to seal the joints, but use sparingly as any excess amount may clog the small hole in the controller fitting and prevent its proper operation.

Pressure Gauge Mounting - To mount beside the pressure

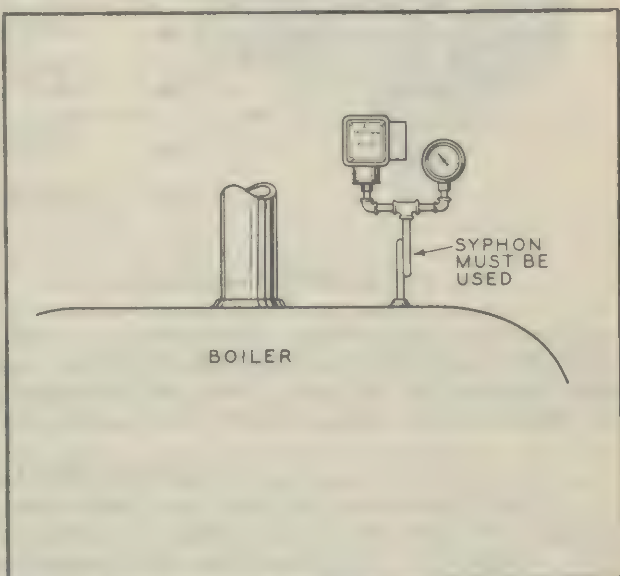


Fig. 1—L404F Typical Pressure Gauge Mounting

gauge, first remove the gauge. Next install a tee and mount the controller and pressure gauge one on each side of the tee. Then connect a syphon between the tee and the boiler.

BOILER MOUNTING - If not convenient to mount controller adjacent to the pressure gauge, mount at the location in the boiler recommended by the boiler manufacturer. All that is necessary for this type of mounting is to screw a syphon into the boiler. Then screw the controller directly to the syphon.

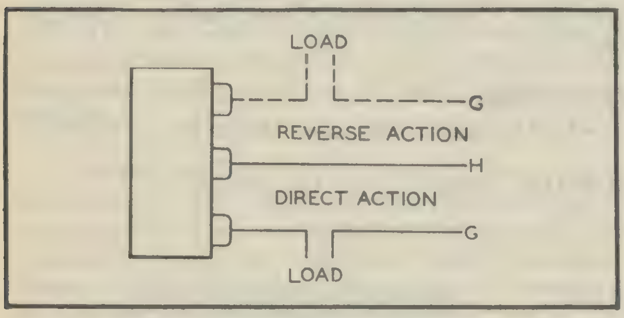


Fig. 2—L404F Connection Diagram.

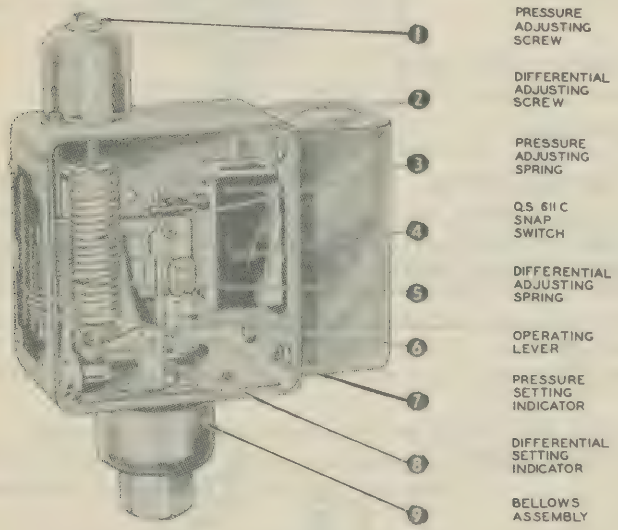


Fig. 3—Type L404F Pressuretrol.

Wiring - Connect as shown in Fig. 2 to open a circuit on pressure rise. For reverse action (to close circuit on pressure rise) remove sticker and connect to upper and middle terminals.

Remove Mounting - When remotely mounted from the boiler, the controller must be on a solid mounting with a suitable piping connection between. This mounting should be at a slightly higher level than the mounting as shown in installation diagram, and the piping must be properly pitched to drain all condensation back into the boiler. *BE SURE THAT A SYPHON IS USED AT ONE END OF PIPING.*

SETTING

Direct-acting connection. When wired as shown in solid lines in Fig. 2 set the pressure setting indicator No. 7 at the cut-in pressure desired by means of pressure adjustment screw No. 1, Fig. 3. Set the differential setting indicator No. 8 for the desired differential by means of differential adjustment screw No. 2. *THE CUT-OUT PRESSURE EQUALS THE CUT-IN PRESSURE PLUS THE DIFFERENTIAL SETTING. FOR EXAMPLE, WITH THE PRESSURE SETTING INDICATOR SET AT 75 LBS. AND THE DIFFERENTIAL SETTING INDICATOR SET AT 12 LBS. THE PRESSURETROL WILL CUT IN AT 75 LBS. AND CUTOUT AT 87 LBS.*

TESTING AND ADJUSTING

After the controller has been installed, wired and set, it should be tested by raising and lowering the pressure to make sure that it operates the controlled devices properly. If the cut-in and cut-out points do not agree with the pressure

gauge on the boiler, the scale plate on the controller may be moved slightly up or down until it agrees with the pressure gauge.

NOTE - This controller has been carefully calibrated at the factory with an accurate gauge. *DO NOT RELY ON INEXPENSIVE PRESSURE GAUGES WHEN CHECKING THE OPERATION.*

DIRECTIONS FOR LOCATING INJECTOR TROUBLES

When your Injector does not work you will probably find the trouble if you read the following very carefully.

THE SUCTION LINE - Go over this pipe from injector connection to strainer. Clean the strainer so it will have full pipe waterway through the meshes. If it is an iron pipe, see that it is free from pitted holes and cracks, and screw up each joint tightly. A globe valve should be screwed on this pipe, so as to allow the water to enter the inlet end of valve. In this way the water will flow up between the valve seal and the valve. Often valve bonnets do not join perfectly with the body of valve, no rare their stuffing boxes always properly packed. To insure a tight valve, repack stuffing box and draw the bonnet tightly to the body. This will prevent air getting in around the stem or between the bonnet joint of valve into the suction pipe. Do not have any more joints in the suction pipe than can possibly be avoided, and to have this pipe as compact as possible screw the tail pipe of injector directly into the outlet end of globe valve, and tighten the coupling firmly to the injector connection. By referring to cut No. 42, illustrating the manner of connecting injector, the suction pipe with the strainer and valve is described perfectly. The pipe with globe valve H shows injector connected to lift. If hose is used for the suction line, it must be strong steam or suction hose that will not kink or collapse. Cheap, light garden or lawn hose must not be used, because it will collapse under the air pressure effected by the vacuum existing in the hose; the hose lining will become loose and curl up, shutting off the pipe area necessary for the injector. When we consider the action of the elements on a suction line for a pump or injector, we perceive there is a vacuum in the pipe into which water flows. Should the joints of this pipe, which are not submerged, but are exposed to the air, not be absolutely tight, the air will flow through the defective joint into the pipe and be carried into the injector. Because you observe no water leaking out of the pipe, do not assume that proof that the pipe is tight, since owing to the vacuum in the pipe, the course of the leak is toward the vacuum. In other words, if the pipe is not tight, the air will leak in, not out of the pipe. To ascertain whether suction pipe leaks - fit a piece of wood under cap Z so as to hold valve P to its seat; cap inlet end of suction pipe and turn on steam which will appear at the leak. (See cut No. 305-N.)

WHEN SUPPLY COMES FROM CITY MAINS - Because injectors are more often used lifting their supply from a source below them than by taking their supply from overhead tanks or city mains, it follows that the great majority of injectors are designed to work better when lifting. Therefore when an injector is connected taking water from mains into which the supply is forced by water works pumps or from overhead tanks from which there is a strong flow to the injector, it is obvious, since the injector is more especially designed for lifting, that the volume of water reaching the injector is considerably greater than when the injector is lifting, and not proportionate with the injector's steam power. For these reasons when an injector is connected to mains or overhead tanks, means must be provided to regulate the volume of water to a quantity proportionate to the steam power of the injector. The most satisfactory method of throttling the water pressure from overhead tanks and city mains is shown by the cut (No. 42) illustrating an injector with a supply line to overheat tank. In this method two globe valves are used in the supply pipe (valves H and M). Valve M is used to hold back the pressure from tank or main, it

being throttled until one may judge the quantity of water flowing through it to equal what would flow through were the valve wide open if the injector were working from a three feet lift. Valve H is used to adjust or grade the quantity of water to injector necessary for the boiler's requirements. To illustrate the above point, suppose the steam pressure to be 80 pounds, and the injector proportioned to handle no more than 600 gallons through 1 inch pipe, on a three feet lift. It is plain that a greater volume would flow through a 1 inch pipe from an overhead source than could be lifted through the pipe from a source located three feet below. It is therefore necessary that the water should be throttled to a certain quantity to equalize with the steam pressure, when taken from an overhead source.

MODE OF CONNECTING
Penberthy Automatic Injector

Cut No. 42

B - Body of Injector. D - Globe Valve in Steam Pipe. F - Check Valve in Delivery Pipe. G - Globe Valve in Delivery Pipe. H - Globe Valve in Suction Pipe. L - Waste Pipe from overflow. M - Second Globe Valve in Water Supply Pipe where an Overhead Tank is used or supply is taken from Water Works Pressure. J - Water Supply taken from Below Injector. K - Water supply taken from Overhead Tank.

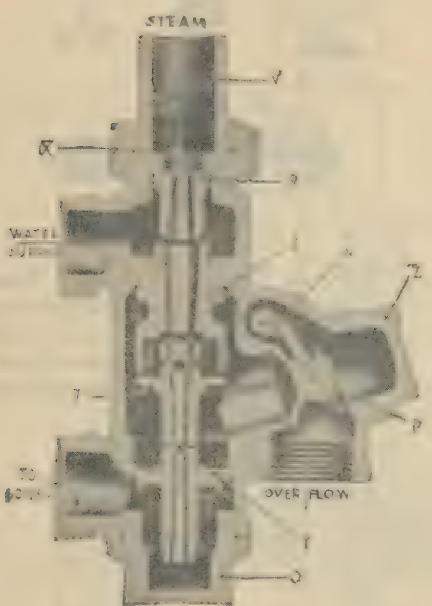
THE STEAM PIPE - This pipe should be connected to take steam from the highest permissible point of boiler, and under no condition must it enter the boiler so near the water level as to syphon water from the boiler to the injector. This pipe must not be tapped into pipes furnishing steam for other uses, because the injector pipe will get all the condensation from the pipe from which it branches. If the injector steam pipe runs straight and direct to highest steam space of boiler from which the injector is not greatly distant, the size of steam pipe may be one size smaller than injector connections; but to be always certain of the requisite amount of steam, we advise steam pipe of the size of injector connection. After this pipe has been put into place on the boiler, and before connecting the injector, it should be blown through by steam, so it will be entirely free of all pipe cuttings and scale when the injector is connected.

THE DELIVERY PIPE - This pipe must have check valve F, which must seat tightly to prevent a back flow of hot water into injector from boiler. Also a stop-valve G must be placed in this pipe to be used when it is necessary to repair check valve - such valves are placed in the order as shown (see cut No. 42). If convenient, it is desirable that the check valve be two feet from injector, but this is not entirely necessary, the idea being to give the injector a working start before the discharge reaches boiler pressure. The water in the delivery pipe attains a very high temperature, thus causing scale and incrustation which fills up and contracts the pipe area to such an extent as to cause excessive friction to the water discharge by injector. Unless this pipe is kept reasonable clear and of sufficient waterway, the back pressure is increased and must be overcome by the injector. To illustrate: - Suppose 100 pounds the boiler

pressure; that the area in delivery pipe is choked by scale so the friction of water through it is great enough to cause an additional back pressure of 50 pounds; the effect on the injector is the same as though it were being worked by a boiler with 100 pounds pressure and discharging into a boiler having 150 pounds pressure. It is therefore extremely necessary to keep a smooth and ample waterway between the injector and boiler. In cases where the water limes and scales badly, it is often necessary to take out the delivery pipe and clean thoroughly, or replace it with new pipe.

CARE OF THE INJECTOR - The injector and its tubes become filled with small gravel, pipe cuttings, pieces of coal, twine, and such matter, and when the injector has been working nicely, but suddenly will not deliver the water to the boiler, but discharges it all through the overflow, some hard substance that will not pass through the tubes has become lodged. To illustrate a remedy for this trouble, we refer to cut No. 305-N, which shows the injector's half sectional line cut vertically through the tubes. Unscrew plug O and remove delivery tube Y, hold it telescope fashion between the eye and light, looking lengthwise through the tapers. You will readily see whether it is obstructed. If it should be, insert a wire of smaller diameter than the bore of tube, into the end which extends into plug O, and push it through the tube forcing the obstruction out. The steam tube R may become obstructed by matter from the steam pipe. This may be removed by uncoupling the steam pipe and cleaning the tube. When high steam pressure is carried or very hot water is supplied to the injector, expecially in cases where the water is dirty, trouble is caused by the lime deposits on the inside of the injector. Incrustation forms on the overflow valve P, preventing its proper seating. Such deposits settle also in the tapers, and spill holes of tube Y. Unless the tubes and overflow valve are kept free from lime deposits the injector will become inoperative. To remove the lime, disconnect injector and soak in a solution containing seven parts water and one part muiratic acid, until the lime is cleaned off then rinse with clean water. Usually one hour will be long enough to soak the injector or parts. Care should be taken that the solution is not too strong and that the parts are not so long soaked as to become damaged. We make injectors as perfect as they can be made. Each injector we make is thoroughly tested on steam boilers. If they do not work up to a rigid test, they are not sold and we assure the user that this injector is capable of working under very hard conditions. Therefore subdue your supposition that the injector is defective, and go over your pipe lines as we have advised, when without doubt you will locate your own trouble. We test each injector at and between 25 and 160 pounds pressure of steam. Working with such pressures they lift three feet from tanks containing water at 74 degrees Fahr. Longer lifts or hotter water decreases the range. As illustrations, if the lift is 20 feet, the injector will work only between the pressures of 60 and 110

Penberthy Automatic Injector
SECTIONAL CUT



Cut No. 305-N

pounds; or if the water has a temperature of 120 degrees to 128 degrees, the injector will work between the pressures of 60 and 110 pounds. There are conditions under which an injector cannot work unless the tubes are designed especially for such work, and if you have carefully followed the suggestions contained in this folder and your injector still refuses to work, fill out the enclosed blank, when, upon its receipt by us, we will furnish you with special tubes exactly designed for your work. If the work you are trying to accomplish is beyond the range of special tubes, we shall advise you accordingly.

CARE OF THE INJECTOR - The body or casing of the injector is never worn out by the effects of any service to which it is subject. It is made heavy and of the best bronze compositions. When connecting the injector the different pipe lines must be brought flush with the injector connections, so when the couplings are tightened up, there shall be no strain great enough to "buckle" the body and throw the jets out of their true alignment. *IF YOU HAMMER THE INJECTOR TO DISLODGE LIME, OR FOR OTHER REASONS, THE JETS WILL NOT AGAIN COME TO THEIR PROPER POSITIONS, AND THE WHOLE MACHINE IS RUINED.* The jets R, S and Y and the valve P are subject to wear, the wear depending on whether the water contains grit and sediment of a rasping nature. The average life of tube Y is two to four years, but there are water conditions that might wear it out in considerably less time. The wear of tube S is not so great. Tube R is not subject to the same causes of wear as S and Y, and rarely needs be renewed. Valve P is regrinding and the user can, as occasion demands, grind it to a good seat by the use of flour emery or fine brick dust. By accident or careless usage the valve seats of body become defective, in which cases the entire machine should be returned to us for repairs the repair work will be done the same day we receive the injector.

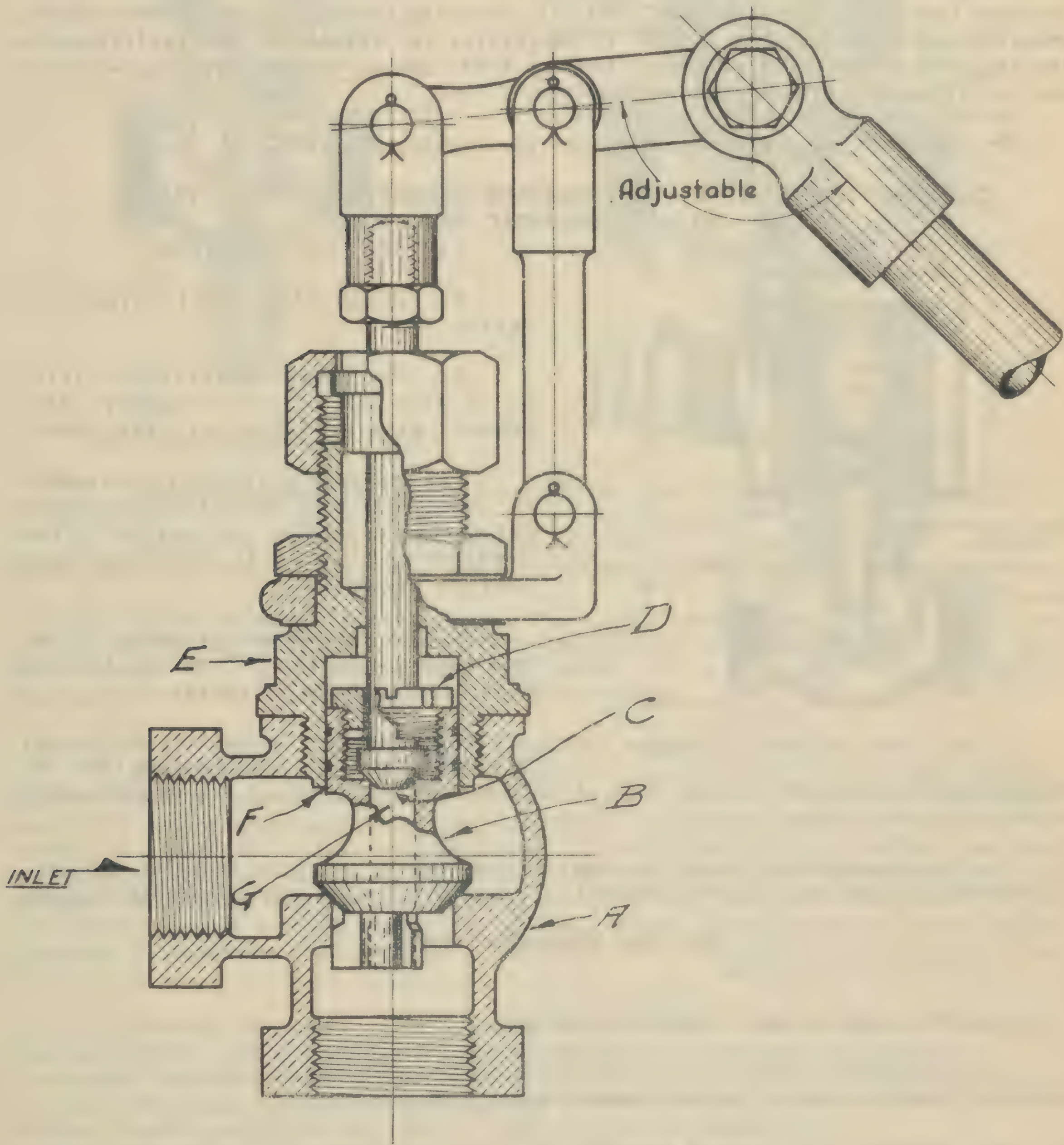
PARTS FOR REPAIRS
Penberthy Automatic Injector

R-Steam Jet.
S-Suction Jet.
Y-Delivery Jet.
O-Plug
V-Tail Pipe
X-Coupling Nut
S-Overflow Cap
P-Overflow Valve
N-Overflow Hinge

Cut No. 31

Bevel seat of piston B contacts seat of body A; these seats are of slightly different angles so that the contact is more or less hair line, making an easy seat to maintain. When this seat leaks, the minimum necessary grinding should be done so as to avoid too wide a seat which ultimately would contribute to an unbalance of the valve, especially on high pressure.

Pilot valve C contacts pilot seat of piston B and should be handled in similar manner to the main seat. The space between the flat shoulder of the pilot valve and the under face of piston nut D should be maintained; this is the pilot valve travel.



3/4" 12T ANGLE BALANCED FLOAT VALVE

If it is misunderstood and assumed to be wear and a washer inserted to take up that travel, the valve will be unbalanced when it closes and the float may not be heavy enough to open the valve.

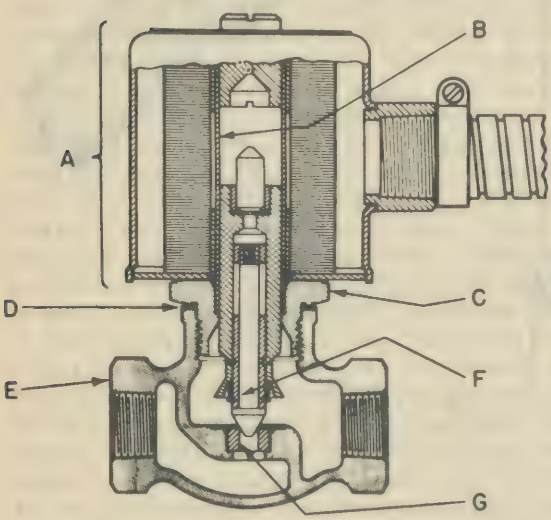
The main seat and pilot seat may be re-ground independent of each other and both seats must be tight for a tight closing valve.

Wear may occur at F where piston B moves in bonnet E. When the wear increases the leak through this fit to a point where the pilot port G is unable to carry off, such leak to the discharge side, the piston will not balance and there will be a tendency to hold to the main seat. This is corrected by building up the bore of the bonnet E and diameter of piston B, if facilities are available, and re-fitting to the original diameter or a piston diameter 5/64" larger that the seat bore in the body as it exists at the time of repairs.

Be sure that the packing box is not too tightly adjusted.

CLEANING INSTRUCTIONS FOR "GENUINE DETROIT" SOLENOID VALVES

NO. 683 SOLENOID VALVES



NO. 683 SOLENOID VALVE

1. Shut off oil line.

2. Break electrical circuit to valve.

3. Disconnect electrical wiring at or near valve, or if easier, disconnect pipe or tubing at valve body.

4. Separate coil housing assembly "A" from valve body "E" using open end or adjustable wrench on hex nut "C". Use caution not to exert force on coil housing assembly.

5. Now the plunger assembly "F" can be removed and seat "G" can be reached for inspection and cleaning.

6. Remove any deposits from plunger "F", seat "G" and plunger guide tube "B" using a suitable solvent for the type of service. Do not use hard, sharp implements or abrasives when cleaning.

7. In re-assembling valve be sure that gasket "D" is free from foreign particles and is in place. Tighten hex nut "C" carefully to prevent subsequent leakage.

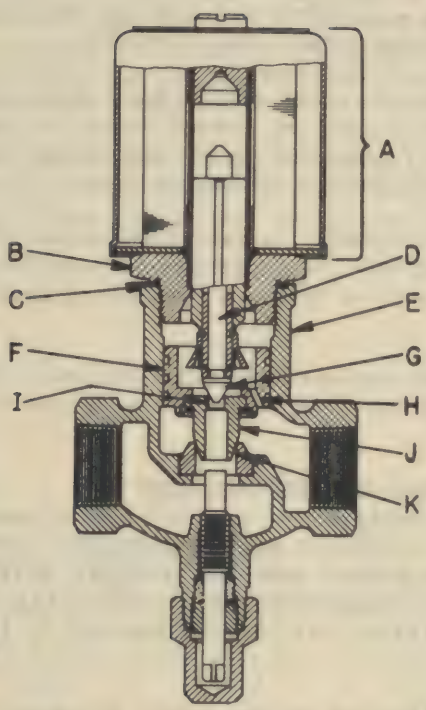
NO. 681 SOLENOID VLAVE

1. Shut off oil line.

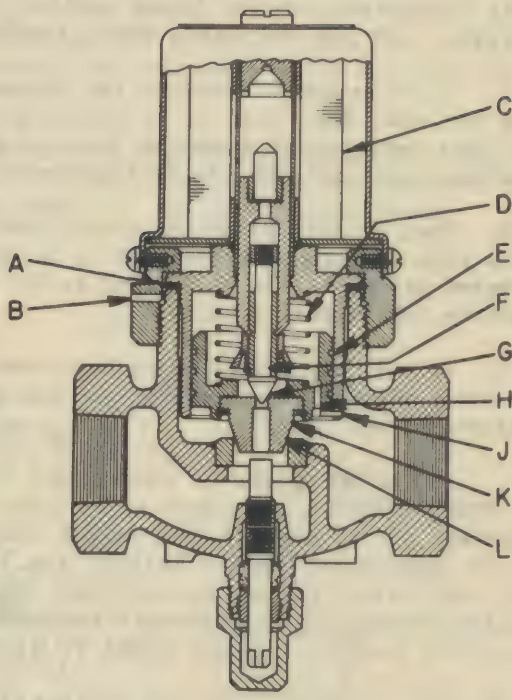
2. Break electrical circuit to valve.

3. Disconnect electrical wiring at or near valve, or if easier, disconnect pipe or tubing at valve body and remove valve from line.

4. Separate coil housing assembly "A" from valve body "E", using open end or adjustable wrench on hex nut "B". Use caution not to exert force on coil housing assembly.



NO. 681 SOLENOID VALVE



NO. 686 SOLENOID VALVE

5. Plunger assembly "D" and piston "F" may now be lifted out for inspection.

6. Remove any deposits from needles "G" and "J", seats "I" and "K", plunger guide tube and bleed orifice "H", using a suitable solvent for the type of service.

7. To re-assemble, place piston "F" in valve body. Next place plunger assembly "D" in seat "I" and then slide coil housing assembly and guide tube down over plunger "D". After making sure that gasket "C" is clean and in place, tighten hex nut "B" firmly against gasket to prevent leakage.

NO. 686 SOLENOID VALVE

1. Shut off oil line and break electrical circuit valve. Unless there is sufficient flexible conduit above the valve to permit removal of the coil housing and coil "C", it is necessary to either disconnect electrical wiring at or near the valve, or remove the valve from the line. If sufficient flexible conduit has been provided, remove two screws at the side of the coil housing and the nameplate screw at the top. In lifting the coil housing from the body, make sure that the coil has not adhered to the plunger guide. If it has, loosen it with a screw driver before completely removing the housing. Otherwise the lead wires may be pulled from the coil.

2. Separate the upper valve assembly from the valve body by means of the large hex nut at "B". This gives access to the main needle and seat "K" and "L".

3. By removing pin "J" the piston "E" and plunger "F" slip out. Now the plunger needle and pilot orifice "F" and "G" can be inspected.

4. Remove any deposits from the needles "F" and "K", seats "G" and "L", the plunger guide tube and the bleed orifice "H" using a suitable solvent for the type of service. Do not use hard, sharp implements or abrasives when cleaning.

5. To re-assemble, replace the plunger "F" in the guide tube. When replacing spring "D", make sure that it is properly centered around the raised bosses in the piston and upper valve assembly; replace piston "E", compress spring and insert pin "J", making sure that the pin is flush with the outer surface of the cylinder.

6. When re-assembling the upper valve and valve body, be sure that gasket "A" is free from foreign particles and is in place. Tighten the large hex nut carefully to prevent leakage. A test opening at "B" is provided so that any leakage at gasket "A" can be immediately detected.

7. If coil and coil housing have been removed, replace them carefully over the guide tube. Replace and tighten the two screws at the side of the housing and the nameplate screw.

EXPLANATION OF NEW MODEL CYCLOTHERM WIRING DIAGRAM

STACK SWITCH - When burner is idle, cold contacts "6" and "7" are closed, hot contact "8" is open, safety switch contact "5" is closed and the relay is "out". When the main power supply switch, the low water cutout and the pressure switch close, the stack switch transformer primary is energized. A circuit also is completed through the transformer secondary, the relay coil, safety contact 5, the warp switch heater, through 6 and 7, B, and W.

The relay pulls in, closing contact "12", starting the burner motor, bringing on the ignition and energizing the solenoid valve.

On the initial rise in stack temperature, hot contact "8" makes, shunting out the warp switch heater. A further rise in stack temperature causes cold contacts "6" and "7" to break. The burner is now in normal operation.

LOW WATER CUTOUT - When the main switch is closed, current is supplied to the primary of the transformer. The flow of magnetic flux induces a voltage in the secondary coil or "electrode circuit coil". No current flows through this circuit unless it is closed.

It can be closed in two ways, either by pressing the low water cutout reset button or through the low water cutout electrode, the water in the boiler and ground. However the circuit can be closed in the latter manner only when the armature is in the horizontal position and the relay contacts are closed.

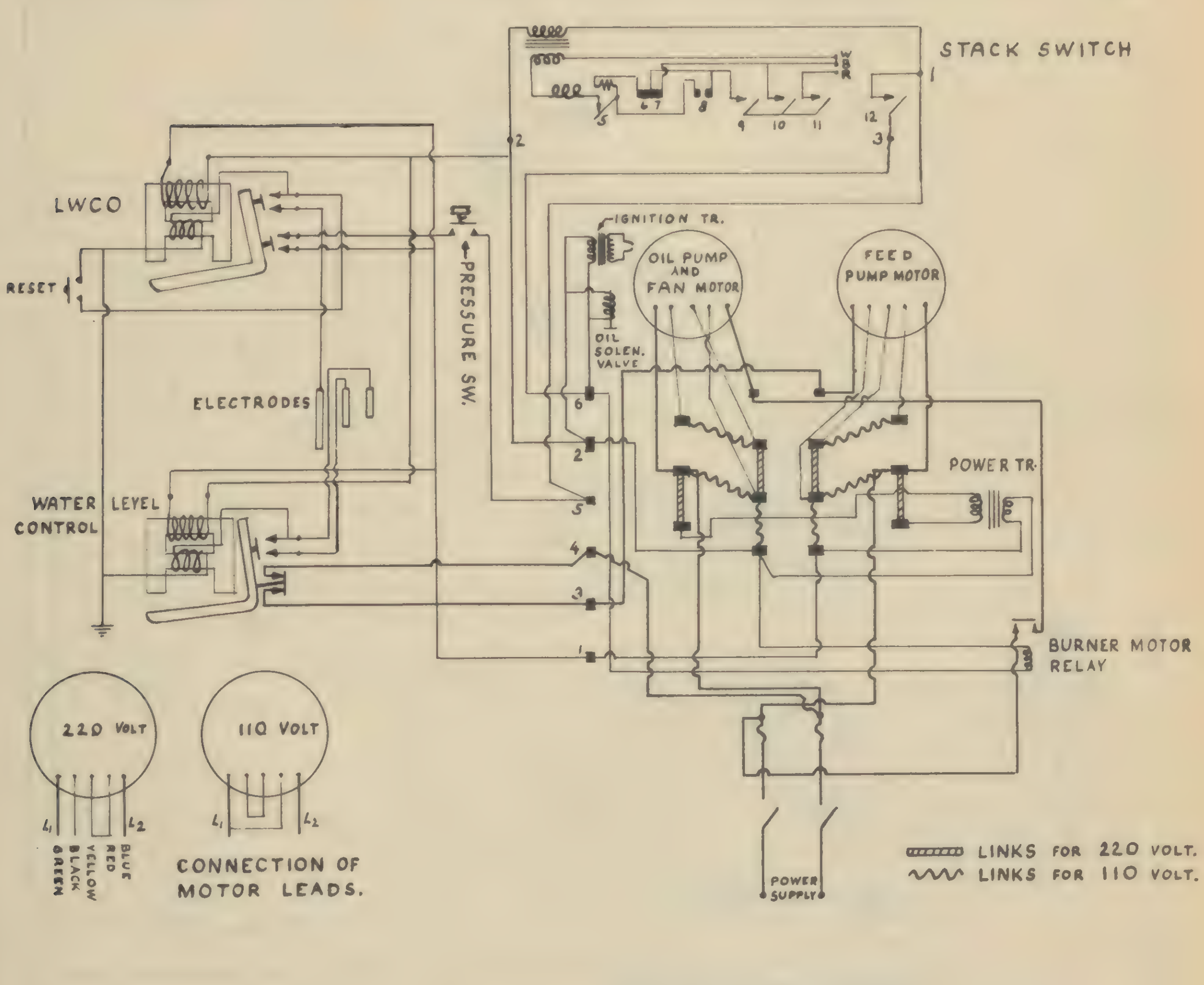
When starting this boiler, it is therefore necessary to press the low water cutout reset button after closing the main switch to energize the transformer secondary which will draw the armature into the horizontal position. When the LWCO reset button is released, the circuit will be kept energized through the electrode, water and ground.

WATER LEVEL CONTROL - This new water level control operates exactly like the one used on the old model cyclotherm.

TO CHANGE FROM 220 VOLT TO 110 VOLT OPERATION OR VICE VERSA - All relays operate on 110 Volt power supply. If the power supply voltage is 220, 110 volts are supplied by the "power transformer". The burner motor and feed pump motor are

220-110 volt motors: they can be adapted to either voltage by merely changing the external connections of the motor leads as shown on the lower left corner of the diagram. By placing the connecting links on the terminal panel in different positions for 110 or 220 volt, those connections of the motor leads are made for 110 volt or 220 volt.

Furthermore, if the connecting links are in the 110 volt position, power is directly supplied to the different relays. If the links are in the 220 volt position, these relays are connected to the secondary of the power transformer.



WIRING DIAGRAM
NEW MODEL CYCLOTHERM

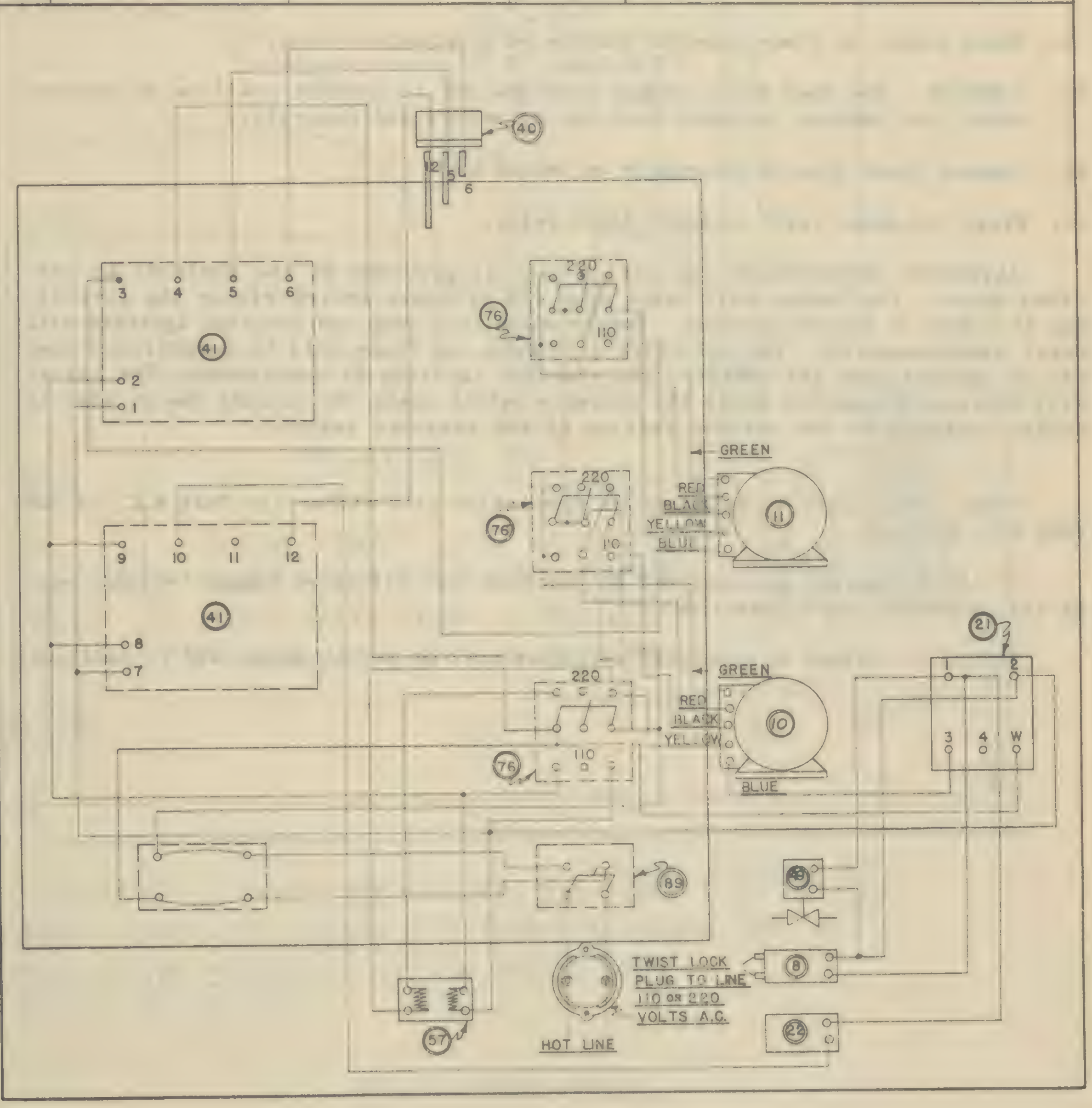
WIRING DIAGRAM OLD STYLE CYCLOTHERM

NO.	DESCRIPTION	MANUFACTURER	TYPE
8	IGNITION TRANSFORMER	WEBSTER ELECTRIC CO.	311 A E F
10	BURNER MOTOR	MARATHON " "	FRAME 184 3/4 H.P.-1725 R.P.M.
11	FEED PUMP MOTOR	" " "	FRAME 184 3/4 H.P.-3450 R.P.M.
21	STACK SWITCH	PENN ELECTRIC SWITCH CO.	672 110-60
22	PRESSURE CONTROL	" " " "	LRPA
40	WATER LEVEL ELECTRODES	CHAS. F. WARRICK	EX-3
41	" " RELAY	" " "	UH-DM
49	OIL SOLENOID VALVE	GENERAL CONTROLS	K 10-1
57	POWER TRANSFORMER	WESTINGHOUSE ELECTRIC	S-920536
76	VOLTAGE SELECTOR SWITCHES	CUTLER HAMMER CO.	CAT. 8661
89	DISCONNECT SWITCH	ARROW HART & HEGEMAN	6465

AMES IRON WORKS
OSWEGO, N.Y.

ELEMENTARY WIRING DIAGRAM FOR
C-12 CYCLOTHERM STEAM GENERATOR
SINGLE PHASE 110-220 VOLTS 60 CYCLES

NO SCALE R.F. 7-30-48



OPERATION OF (OLD STYLE) CYCLOTHERM

1. Be sure there is water in the boiler.

2. Adjust pressure control to approximate maximum boiler pressure desired.

3. See that line switches to the burner and boiler feed pumps have proper fuses.

4. Check oil lines to be sure valves are open.

5. See that boiler feed pump has water supply.

6. See that oil is in tank.

7. See that burner relay is in starting position (push reset button).

8. Stack switch or flame detector must be in starting position.

*9. CAUTION See that three toggle switches are in correct position to conform with line voltage to avoid burn out of motors and controls.

10. Connect power line to receptacle on switch box.

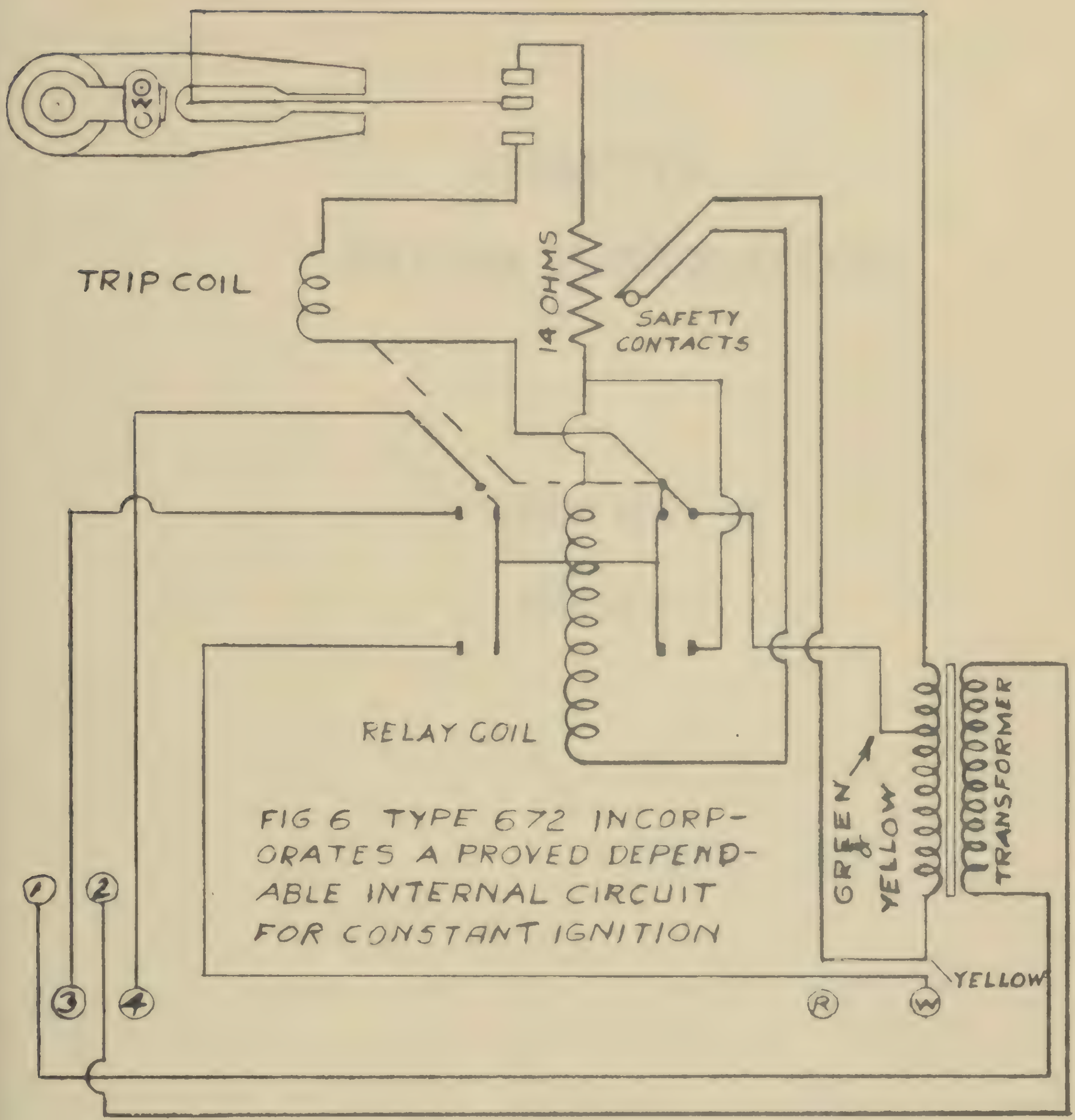
11. Press low water reset on water level relay.

AUTOMATIC OPERATION of the entire unit is provided by the controls as outlined above. The burner will start when the pressure switch closes the circuit, due to a drop in boiler pressure. Burner motor, oil pump and electric ignition will start simultaneously. The oil valve will open and flame will be established when oil is sprayed from the nozzle. The electric ignition is continuous. The burner will continue to operate until the pressure switch opens the circuit due to rise in boiler pressure to the maximum setting of the pressure switch.

*N.B. - This unit is equipped for connection with either 110 Volt A.C. *or* 220 Volt A.C. current.

If 110 V. current is connected to junction box, all three toggle switches *must* be set at marked 110 V. position.

If 220 V. current is connected, switches must be set at marked 220 V. position.



SPLICE R & W REMOVE SCREW FROM 4
TAKE CONTACT WIRE FROM 1 SOLDER ON W
3 & W IN SERIES WITH MOTOR
4 AND R BLANK

NO. 672 PENN SWITCH

CHAPTER X
STEAM GENERATORS

SECTION 2
OILBILT

INSTALLATION INSTRUCTIONS
OILBILT STEAM GENERATING PLANTS

The OILBILT Steam Generating Plant is a compact, self-contained, highly efficient steam unit. In order to assure the highest type of performance, the installation and operation of the unit deserves careful consideration and study. These instructions are intended to guide the engineer or operator responsible for this work.

The various recommendations contained in these instructions are not intended to supplant requirements of any Federal, State, or Local Codes having jurisdiction, and it is urged that such authorities be consulted in case of questions before installations are made. Particular reference is had to oil piping and storage systems, electrical service, boiler piping furnished by the customer, etc.

BOILER LOCATION - While the exact location of the boiler depends on many factors, the boiler should be placed with sufficient regard to future operating considerations. Provide the maximum clearance possible for accessibility of manholes, handholes, blow-off cocks. Aisle space is usually desirable along both sides of the boiler frame. It is most important to provide adequate clearance at the rear end of the boilers, *about equal to the fire tube length* to permit removal and cleaning of tubes. This clearance can be obtained by installing a proper sized door in the building wall at the rear of the boiler, this door also to serve for installation purposes. In such cases, however, the boiler should not be closer to the rear door than 3 to 4 feet to permit removal or opening of the rear door.

Cleaning the tubes from the front end of the boiler is possible, but seldom recommended as it entails removal of burner equipment and accessories.

Boilers are constructed with two saddle supports which are built into a box channel frame of such design that the complete unit may be set on any average concrete floor without construction of a special slab or extra foundation. Sometimes it is desirable to raise the channel frame from two to six inches above the floor level, providing for this purpose three piers, one under each of the boiler saddles and one under the front burner extension. This is considered desirable in the case of small diameter boilers to raise the burner up to a convenient operating height and in all boilers it provides a means of draining or sweeping out the area inside the box frame. When piers are not used, we recommend that the channel frame be shimmed up with steel plate shims at least four to each side, with additional shims under the boiler saddles and the end of the frame. After these shims or foundations are prepared *and the boiler is set exactly level*, the entire area under the box channel frame may be grouted with stiff cement. By leaving small opening about 4" wide on each side of the frame, there is provided a drain inside of the frame which is useful at times when boiler is washed out. Some operators install a catch basin and floor drain inside of the frame and directly under the boiler, which is also a good method.

INSTALLING THE BOILER - In unloading and setting the boiler, the lifting rings provided in the boiler shell should be used, otherwise it is customary to use slings under the boiler shell proper.

After the boiler is brought up to normal steam pressure, check all manholes, handholes and connections for leaks. Continual leakage of handhole gaskets will damage the boiler shell around the handhole openings. Use graphite to coat the shell side of manhole and handhole gaskets.

Re-tighten bolts on front and rear heads of boiler. If head gaskets leak, they may be usually tightened by applying black asbestos furnace putty. Graphite is also recommended for coating the head gaskets whenever end doors are opened.

Any unused plug connections in the boiler shell should be permanently closed with solid type plugs. Such plugs as may be furnished with the boiler are primarily inserted for testing purposes and should be changed when such connections are not made use of.

While all boilers are subjected to hydrostatic test in the shop under the supervision of the Insurance Inspectors, and in addition the firing test of the boiler serves as a further pressure test, no guarantee can be given that slight leaks will not occur due to shock or strains sustained in shipping or unloading the boiler. Such minor leaks may readily be corrected in the field by ordinary methods.

The leakage of flue gases at the shell extension may also require correction in the field if the joints have dried out or gaskets have shrunk.

Where it becomes necessary to open the rear doors, the joints must be resealed with #2 asbestos fiber, slightly moistened. Do not use any type of fire cement which will set up hard on the door joints.

Stack connections should be of adequate size and as direct as possible. Since all air for combustion is supplied under positive pressure by the blowers, there is sufficient pressure at the vent outlet of the boiler to force the flue gases through the standard size of vent pipe provided. The stack extensions to be attached to the standard vent stub supplied with the boiler may extend vertically upward through the boiler room roof. The height of stack above the roof depends on adjoining buildings, and other conditions and must be sufficient to postively eliminate downdraft.

When the vent pipe is to be connected into existing smoke breeching or chimneys, the size of such chimneys should be at least equal to the vent size on the boiler plus the area of any other stacks connecting into such chimney. On long horizontal runs of vent pipe, where a number of elbows are employed or where special problems are encountered, the company, will, upon request, make recommendations.

BOILER FEED SYSTEM - Although the general subject of water supply and treatment cannot be properly covered in this manual, it is one of extreme importance and it is well for the operator to give serious thought to the water problem. Whenever it is possible to reclaim a substantial portion of the steam condensate, such condensate should be piped to the receiver (#23 - Fig. 4) with 3/4" pipe and fittings provided with the unit, from where it is pumped to the boiler at the command of the float control. The condensate receiver is fitted with a float controlled make-up valve to admit water when the supply of returned condensate is insufficient. A 3/4" supply line must be brought to the receiver at the make-up valve connection (#17 - Fig. 3) from a cold water source under a pressure of 20 pounds or greater. The failure to return all available condensate to the boiler wastes heat and water and increases the scale forming substances which are admitted with raw water.

The unit is provided with a properly sized boiler feed pump which returns water from the receiver into the boiler (#29 - Fig. 5). The pump suction line is fitted with a strainer, and discharge piped to boiler fitted with proper globe and check valves and pressure gauge. The pump starter is mounted on the OILBILT control panel (#7 - Fig. 1) and operated by the boiler water level control (#34 - Fig. 6). For recommended care and maintenance of pump and motor refer to instructions in the appendix of this manual.

An injector (#35 - Fig. 6) is provided as an integral part of the Unit for admitting boiler feed water when for any reason the boiler feed pump cannot be used.

ELECTRICAL SERVICE - The OILBILT Unit for which this manual is written is provided with motors and controls intended for operation on 110 volt, single phase, 60 cycle current. Two-wire electrical service of this characteristic must be brought to the OILBILT panel (#38 - Fig. 1) and connected to the burner starter at terminals L_1 and L_2 (#5 - Fig. 1). The service leads must be #12 copper wire or larger, and fused for a minimum of 30 amps.

Because the OILBILT Unit receives actual operating tests before shipment, the internal wiring connections should require no change. Whenever it becomes necessary to replace any electrical control device, motor, etc., all wiring connections should be plainly marked on both sides of the breaks made in the wiring in order that such device be reconnected in its proper phase. Failure to use this ordinary care may require complete tracing of the internal wiring so that the various motors and controls are properly interlocked.

Wiring which has been disconnected to dismantle parts prior to shipment, is so marked or tagged that it can readily be reconnected if ordinary care is used. In case of question, reference can be made to the internal wiring diagram in the appendix of this manual.

INSTALLATION INSTRUCTIONS
OIL STORAGE AND PIPING SYSTEMS FOR LIGHT OIL UNITS

Light oil units are constructed with an integral fuel pump mounted at the boiler front and driven by the blower motor. It is necessary to run suction and return lines between this fuel pump and the oil storage tank with 3/8" O.D. copper tubing and fitting provided with the unit. If leaks develop in the suction line, air will be drawn in and either cause flame failure or uncertain ignition. Air leaks are usually evidenced by an inability of the pump to deliver full quantity or pressure. Air leaks may be detected by using a vacuum gauge on the pump suction line. All joints, valve bonnets, etc., in the oil piping should be absolutely tight. Joints and pipe threads should receive a coating of shellac, rather than any ordinary pipe dope which may be attacked by the oil.

The check valve in the burner piping prevents the suction line from emptying during periods when the boiler is shut down and enables instant and positive restarting of the burner. The suction line is connected into the oil strainer of the pump. The return line connects into the outlet of the pressure regulator on the discharge side of the pump. Avoid getting excess shellac on pipe joints as it will cause trouble in the oil strainer, pump, Solenoid oil valve and burner nozzles.

A globe valve is provided in the suction line close to the pump for seasonal shut down, but in such installations *the burner must never be operated with the valve closed* as damage can be done to strainer and pump by the vacuum thus created.

Fuel oil tanks for light oils must be located and installed to conform with local and other regulations (insurance). In very cold climates the protection of these tanks from extreme cold by burying them underground or placing them in partially heated buildings helps to secure uniform atomization of the oil throughout the year. Very cold oils increase in density so that the delivery capacity of nozzles increases, and, moreover, nozzles do not atomize perfectly when oil is at very low temperatures.

No operator should attempt to start up the OILBILT without first having a clear understanding of the oil pumping system, the boiler feed system, the burner and its electrical controls, the boiler and its construction.

When the OILBILT is started up under the direction of a factory engineer, preliminary instruction on the above points will always be given. In the event such instruction has not been received by a new operator, we urge that he study carefully all information given in this manual.

FUEL OIL - Fuel oils defined by the Petroleum Institute as No. 1, No. 2, or No. 3 may be used in the OILBILT burner. Because of a tendency on the part of various oil distributors to classify these oils by other numbers, the operator is cautioned to check the specifications of any fuel oil offered him. *No fuel heavier than the above standard No. 3 or having a viscosity in excess of 50 seconds Sayboldt Universal at 100° F. will atomize perfectly or ignite postively.* Heavier oils show an increase in heating value (BTU) over the lighter grades, but it is a mistake to purchase an oil for the sake of its greater heating value alone when it becomes impossible to get good atomization or positive ignition. When oil storage tanks are exposed to extremely cold temperatures, certain grades of No. 3 oil will atomize less readily, and if the tanks cannot be relocated, the use of a lighter grade of oil (No. 2). may sometimes present a remedy.

OPERATION OF THE FUEL OIL PUMPING SYSTEM - The pump which draws oil from the storage tank and pumps it to the burner, is mounted on the burner base at the front of the boiler. This pump is driven from the blower motor and starts as soon as the blower motor operates. Since the pump has a capacity in excess of the oil required by the burner nozzles, a portion of the oil is always returned to the oil storage tank. This return line is connected at the outlet of a relief valve on the pressure side of the pump. This relief valve is regulated by means of an adjustment nut to deliver about 100# pressure at the pump discharge. Oil passes from the pump through a Solenoid valve direct to the burner nozzle or nozzles, depending on the type of burner supplied. A strainer will be found on the suction side of the pump to prevent admission of dirt or foreign material into the closely fitted pump internals or the burner nozzles.

It is highly important that the fuel pump deliver an adequate supply of oil at the required pressure at the instant that the burner starts up. Hence it is always required that the oil suction line be free from leakage, the strainer clean and the pump in good mechanical condition.

A pressure gauge is mounted after the pump to indicate the oil pressure.

THE OIL BURNER - The complete oil burner consists of the motor driven blower supplying all air for combustion through the burner tube, the burner nozzle and ignition electrodes being located in this tube where it attaches to the main fire tube of the boiler.

The inner burner assembly is mounted within the blower tube by means of the removable plate at the rear of the blower which permits its removal for adjustment or repairs.

Heavily insulated, high-voltage type ignition cable connects the ignition transformer (#3 - Fig. 1) to porcelain adapters in the rear burner plate. Special spring-type ignition cable connects the burner side of these porcelain adapters to the electrodes by means of hook eyelets.

An air diffuser plate is mounted at the front of the inner burner assembly. The position of this plate may be adjusted by an external screw, the position of which is set at the factory so as to require no further adjustment. The position of this plate affects the admission of air for proper combustion and flame action.

Refer to drawings in the appendix of this manual for standard settings of the diffuser plate, electrodes and other parts of the burner.

The blower is equipped with a lever operated damper to regulate the air supply for the given oil nozzle capacity.

A small sight hole in the burner tube as well as in the front plate of the burner permits observation of ignition and flame condition.

OPERATION OF THE ELECTRICAL CONTROLS - In following the description of these controls, the operator should refer to the internal wiring diagram and bulletins furnished in this manual.

On the OILBILT Panel, the blower motor starter (#5 - Fig. 1) is located at the left hand side, the boiler feed pump starter (#7 - Fig. 1) at the right, and the Protectorelay (#6 - Fig. 1) in the center. A snap switch is mounted on the blower starter to provide a means for starting and stopping the burner manually and for testing purposes. A push-button is mounted on the boiler feed pump starter for manually starting the pump when it is desired to fill the boiler with water by this means, and to raise boiler water to high level before blowing down.

The burner operation is controlled entirely by means of a steam pressuretrol mounted near the water column. This is an adjustable device to permit operating the boiler at any range of steam pressures desired. It contains a switch which closes when the steam pressure drops to a set point, and restarts the burner. When a set maximum pressure is reached this pressuretrol switch opens and shuts down the burner.

The actual starting operation is carried out automatically by the Protectorelay which performs the following functions when the pressuretrol calls for burner operation:

1. Left hand #1 relay closes and simultaneously starts up the bl wer and fuel pump, opens the Solenoid oil valve and closed the ignition circuit so as to deliver a spark at the electrodes.
2. If ignition takes place promptly, the #2 and #3 relays also close. The #2 relay serves only to cut off the ignition circuit which in usual practice is operated only for a short period when the burner is first ignited. The #3 relay (besides other functions) cuts out the starting circuit and it is this relay which first drops out whenever the Pyrostat breaks its contact on flame failure.

Should oil fail to ignite after a normal start, the Pyrostat will not respond hence #3 relay will not close. At the expiration of the timing of the Thermal Safety Switch, a safety shutdown will occur.

When burner shutdown is called for by the steam pressuretrol, the #3 relay drops out first and is immediately followed by #1 and #2

A normal shutdown caused by this method may be followed by automatic re-ignition when the pressuretrol again calls for burner operation.

When flame failure occurs, the #3 relay drops out first and then #1 and #2.

A flame failure shutdown trips the Thermal Safety Switch in the Protectorelay and to restart the burner, the reset button on the Protectorelay must be depressed and released.

For more complete details on the operation of the Protectorelay refer to bulletins in the appendix.

Interlocked with the Protectorelay are two or more "Safety Controls", the first being a flame failure device (Pyrostat - #11 - Fig. 1) mounted in the boiler stack, and the other consisting of low water cut-offs integral with the boiler water level control (#84 - Fig. 6).

The flame failure control acts to shut down the burner motor driving the fuel pump and air blower, as well as the Solenoid oil valve, in the event of oil failure or unsuccessful ignition.

The low water cut-off performs the same kind of shutdown so as to prevent operating the boiler with insufficient water. The burner cannot be started unless the low water cut-off is in "closed" position. Detailed instructions on the flame failure control (Pyrostat) will be found in the appendix. *This control must have its contacts open when starting the burner.*

STARTING THE BURNER FOR FIRST TIME - On a new unit first check the lubrication of the blower motor, blower bearings, and boiler feed pump motor. Also check both motors for proper rotation.

See that the boiler is filled with water and that the automatic boiler feed pump control cuts the pump in and out when the float switch is moved up and down by hand.

CLOSE THE HAND OPERATED VALVE BETWEEN THE OIL PUMP AND THE BURNER to prevent flow of oil while testing the fuel pump and pressure regulator. The Pyrostat (if correctly positioned) should have its contact points at the open position before a start can be made. To do this twist the spiral coil one-quarter turn to the left and let go. The contacts should separate. (See bulletin in appendix for further details).

Now start the burner motor by first closing the main service switch and then the auxiliary snap switch on the OILBILT panel. The starting of the pump should fill the oil suction line and develop a pressure of 100# on the oil gauge. On long suction lines this pressure may not come up quickly and, rather than operate the fuel pump without internal lubrication for a prolonged period, it is safer to prime the line. A dirty check valve or leaky suction line will also prevent getting oil pressure up to required point.

When this preliminary pumping is carried on for too long a period, it is possible for the safety timing switch (in the Protectorelay) to cut out the motor in the same manner as it does when an ignition failure prevents the burner from lighting. To continue operating the motor under these conditions, simply hold the #1 relay in closed position by hand.

After the entire testing operation shows that the burner motor starts up, that oil pressure is immediately established, and than an ignition spark is visible through the sight hole of the burner, the burner is ready to light.

With the snap switch or main service switch off, open the hand oil valve. Now close the switch and when burner starts adjust the air damper on the blower so that the stack gases show a slightly smoky condition. Then increase air slightly so that smoky condition just disappears. This will be the most efficient setting. *The further opening of the air damper beyond the point where smoke clears up, simply*

puts excess air through the burner and because this air leaves the boiler at high temperature, it means a waste of fuel.

CONDENSATION IN STACK - When the boiler is started for the first time, condensation from the products of combustion as well as moisture from brickwork will run out of the bottom plugs in the front and rear flue extensions. After this ceases plugs should be put in these two openings.

OIL PUMP OPERATION - The failure of a fuel pump to operate at full capacity or deliver sufficient pressure may be due to one of the following reasons:

1. No fuel oil in tank.
2. Suction line leaks, prevent pump from priming.
3. Foot valve obstructed so that suction line empties after boiler is shut down and delays or prevents priming of pump.
4. Oil strainer clogged.
5. Burner nozzle strainers plugged.
6. Pump badly worn.
7. Undersized suction piping.

The oil pump furnished is a very accurately fitted piece of equipment. It employes a mechanical seal on the shaft to prevent oil leakage. Internal wear of the pump may take place due to the presence of dirt in the oil and in time this will result in excessive clearances which reduce the pump capacity.

Whenever the fuel pump fails to deliver full capacity or pressure, order a replacement pump at once and send the old pump in for repairs or exchange (where allowed). We urge that no attempt be made to disassemble these pumps in the field where the absence of proper tools or knowledge can easily cause damage which will ruin the pump.

OIL STRAINERS - Oil strainers should be cleaned regularly. The basket is removable on suction strainers, but when replacing be sure to return the cover gasket and carefully tighten cover bolts so no air leaks can occur.

Nozzle strainers should likewise be cleaned at regular intervals.

OIL NOZZLES - The successful operation of the burner depends on the use of proper style nozzle tips and on keeping the nozzle orifices clean. Nozzle tips standardly furnished with OILBILT units, are of a special type which delivers a solid cone spray of extreme fineness, and at such an angle as to insure proper mixing with the air stream through the burner. Unsatisfactory burner performance and loss of efficiency may follow the use of non-standard tips.

To clean the nozzles, remove the inner burner assembly and remove the tips and nozzle bodies from the burner manifold. The nozzle tips are disassembled by screwing out the internal portion. Carefully clean all parts using lacquer thinner for the orifice. Never use wire or sharp tools as they will destroy the orifice and render the nozzle unfit for further use.

ELECTRODES AND IGNITION CABLE - Failure to set or keep electrodes in their proper position accounts for much faulty burner operation. Not only must the gap be correct but the electrode points must be carefully located with respect to the nozzle itself as shown on drawings in the appendix. Sometimes difficulty in securing the electrodes in their clamps can be corrected by using light metal shims around the porcelain. Defective or cracked porcelains require immediate replacement to prevent short circuiting of the spark. A gradual wearing away of the electrode

tips requires respacing of the points or replacement of the entire electrode.

The ignition cable used on OILBILTS is designed for 15,000 volts which is overcapacity for the 6000 volt ignition transformer. Ignition cable should not be exposed to moisture, abrasion or rough handling if long life is to be obtained. See that the connectors are in perfect contact with the cable ends. Unscrewing the snap portion of the connector will show whether this is true.

PROTECTORELAY - A special bulletin in the appendix describes the care and maintenance required for this instrument.

The cover should be kept in place to avoid dust and dirt from getting on the relay contacts. Textile fibres, or dust will prevent perfect contact of delicate relay points and destroy the action of the entire control.

Never use oil on any part of the Protectorelay.

PYROSTAT - Occasional cleaning of the Pyrostat element and contact points may be required. The cleaning should be done as described in the bulletin on this instrument.

If the Pyrostat fails to function due to a slipping of the shaft "clutch" or for other reasons, it is advisable to replace with a new control, having the old one repaired and held as a spare part.

LUBRICATION - The lubrication of motors and blowers should follow the best practice for the type of bearings furnished. Regularity in the lubrication schedule is most important.

Ball bearings suffer as much from over-lubrication as under-lubrication, and care should be used not to force excessive grease under pressure into bearing housings.

Failure to check lubrication regularly will result in unnecessary wear of bearings and shafts. Where such failures take place, excessive vibration will be noted and such vibration can have undesirable effects on the relays of the burner control.

PACKING GLANDS - The shaft packing on boiler feed pumps should not be tightened excessively. It is preferable to have a slow drip from the pump packing glands. The type of packing usually recommended is semi-metallic in nature and excessive tightening compresses this material to a point where it produces a severe drag on the pump motor, besides scoring the shaft.

CLEANING THE BOILER FIRE TUBES - The fire tubes in the second, third and fourth passes of the boiler should be cleaned periodically, depending on the number of hours operated each day. The first period should be about three to four months after which the operator's experience will be a guide.

To clean the fire tubes, open the rear door and the bottom panel on the rear boiler head or flue extension. Open one of the clean-out doors on the side of the front flue extension, also the bolted cover on the flue header opposite the side on which the vent pipe is attached.

Wire brush all flues to loosen the carbon, then go over all flues with a rag wrapped around the wire brush. The carbon can then be hoed out of the various openings mentioned above.

The use of air or steam to blow out tubes usually spreads too much dirt around the boiler room and does not do as good a job as the method outlined above.

After cleaning the fire tubes, care should be used in resealing all openings to prevent leakage of flue gases or soot. Recoat all woven asbestos gaskets with graphite and oil, filling in cracks with asbestos putty. Use #2 asbestos fibre, slightly moist as a mortar seal around brickwork joints of the doors.

When the rear doors are opened, check the condition of the firebrick and if cracks or failures appear, repoint all joints. A wash coat of air setting high temperature cement will also help secure long life of the brickwork.

WASHING OUT THE BOILER - The washing out of the water side is so important yet dependent on so many local conditions, such as type and quality of raw make-up, type of treatment used, etc., that only general rules can be given in this manual. Where considerable make-up water is employed and unless the water treatment has been carried out under expert control, every new boiler should be opened after a few months time and inspected for scale formation. This will give some basis to work out future wash-down periods. It is also required to do this washing when boilers sre shut down for insurance inspection.

The Cleaver-Brooks Company cannot act as a consulant or prescribe methods for water treatment, which is highly specialized business, but will gladly refer customers to reputable concerns who can render this service.

SPARE PARTS - The OILBILT will give most satisfactory service when its various parts are kept properly maintained. Where interruptions to operation of the boiler are apt to affect plant production or where no spare boilers are available, it is good judgment to carry a stock of certain emergency parts. A supply of such spare parts in accordance with the attached list is provided with each machine and packed in a special case mounted on the burner base plate (#4 - Fig. 1).

Each unit is further provided with pipe, fittings, and valves intended to complete the service connections ready for operation. These accessory fittings are boxed separately, and in accordance with the attached list.

BLOWING DOWN THE BOILER - The OILBILT UNIT for which this manual is intended is provided with blow-down valves completely installed as an integral part of the machine. In blowing down, the correct procedure is to open the positive shut-off "Y" valve (#30 - Fig. 5) first, and to blow-down by means of the quick-opening valve (#24 - Fig. 4). Amount and frequency of blow-down is dependent upon existing local water conditions, but the unit should be blown-down for at least two 10 second intervals every eight hours. Water column bowl should be blown-down (#36 - Fig. 6) also in accordance with the above.

GENERAL HOUSEKEEPING - An OILBILT which is kept clean and properly maintained is the mark of a good operator. Immediate correction of oil leaks, daily cleaning up of the boiler front, regular wiping of exposed piping and parts will repay the effort.

After construction forces have completed their work, it is suggested that the boiler frame and heads be repainted with heat resisting material.

Check all steam and water leaks and at the first opportunity correct them. Do not permit leaky handholes to go unattended as a certain amount of corrosion will take place at these openings in the boiler shell.

Use sawdust or other material to soak up all oil which leaks out when strainers are opened or piping drained.

Repair leaky tricocks promptly. Most types may be reseated or cleaned readily.

Be sure to check hand gaskets, and explosion door gaskets, as their perfect tightness will eliminate gases and soot from entering the boiler room.

Keep a list of all maintenance items which must be deferred until the boiler can be shut down for washing or inspection, and do these jobs at this time.

Finally, remember that the OILBILT is a fine piece of machinery. It deserves the same good care you would give any other important machine in your plant so as to get long and satisfactory service.

TYPE C40A PYROSTAT

This safety device is designed for use in conjunction with Protectorelays and is mounted in the smoke-pipe close to the boiler or furnace. The bi-metal helical element of the Pyrostat responds to changes in the flue gas temperature, and thereby prevents continued operation of the oil burner under abnormal or unsafe conditions.

SPECIFICATIONS

TYPES - C40A Pyrostat -- For 2-wire low voltage or low ampere line voltage control. Use with Types R100A, R113A, R114A, R161A, B or C Protectorelays.

ELECTRICAL RATING - 1/2 ampere, 20 volts; 1/4 ampere, 110 volts; 1/8 ampere, 220 volts.

ELEMENT LENGTH - Adjustable 6 to 7¼" insertion.

MOUNTING MEANS - Flat flange.

MAXIMUM OPERATING TEMPERATURE - 1100° F.

CASE DIMENSIONS - Height 5-3/4", width 3-7/8", depth 2-1/8".

WHEN ORDERING SPECIFY - Type number.

INSTALLATION

TO MOUNT - 1. Drill a 1-5/8" hole in the smoke-pipe close to the furnace or boiler where the Pyrostat element may be placed in the direct path of the flue gases. Be sure, however, that the flue gas temperature does not exceed 1100° F. at the location selected, and, if necessary, mount the Pyrostat at some cooler point farther away from the furnace or boiler. If a draft regulator is used, the Pyrostat must be mounted between it and the furnace or boiler to prevent cold air from coming in contact with the helical element. Some city ordinances require that dampers be removed from the smoke-pipe or stack on oil burner installations.

2. Remove the mounting bracket (1-Fig. 1) and place it over the hole in the smoke-pipe, and, using it as a templet, mark the location of screw holes in the mounting bracket on the pipe.

3. With the sheet metal screws furnished, fasten the mounting bracket to smoke-pipe.

4. Insert the bi-metal helical element into the mounting bracket, being careful not to bump the element against the side of the hole. Do not permit the element to touch any part of the smoke-pipe. Level the case and then tighten the set screw in the mounting bracket.

WIRING - A 1/2" conduit opening is provided in the bottom of the Pyrostat case for use in wiring with BX or conduit when the Pyrostat is used in a line voltage circuit. No. 14 rubber covered wire should be used for either line or low voltage wiring to Pyrostat. Be sure that all wiring complies with local electrical ordinances.

For the correct wiring diagram, refer to the inside cover of the Protectorelay with which the Pyrostat will be used.

After the wiring is completed be sure to check the operation of all controls under an actual running test.

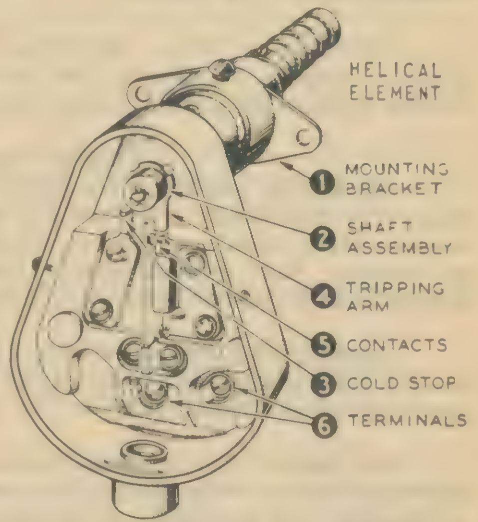


Fig. 1—Internal view of C40A Pyrostat

TYPE C40A PYROSTAT - This model is a "two-wire" control which closes its contacts on a slight rise in stack temperature. The contact operating mechanism is equipped with a friction clutch which allows the bi-metal helix and shaft to continue rotating as the temperature rises. Then when the stack temperature drops slightly, the contacts open immediately. The contacts, therefore, open or close with a change in stack temperature rather than at any fixed temperatures.

The C40A Pyrostat has no adjustments to make. It is necessary, however, that the contacts be open (separated) before the Protectorelay can operate to start the burner. If they are closed, they may be opened by moving the tripping arm (4-Fig. 1) over against the cold stop (3) with your finger.

INSTALLATION DATA - TYPE R100A PROTECTORELAY

TO INSTALL ALL TYPES - The above types are designed for location on a wall or column free from excessive vibrations. It is not recommended to mount the control on a rafter or beam close to the ceiling.

TO MOUNT - With screws furnished, mount the control securely, with the care level, at the selected location.

TO WIRE - All wiring must comply with local electrical ordinances.

Use No. 14 rubber covered wire, run in rigid conduit or BX, for high voltage wiring. Standard thermostat cable can be used for low voltage wiring.

A type C40-1 Pyrostat or Type C57-1 Protectostat, to provide positive timing of ignition, must be connected to the No. 2 and 5 terminals on the relay terminal strip.

Refer to Figs. 1 and 2 for typical wiring diagrams.

Refer to Fig. 5 for the schematic circuit diagram when the R100A is used with A.C. current--Fig. 4 when used with D.C. Current.

A two wire line voltage, Minneapolis-Honeywell limiting device, connected in the hot supply line is recommended for use with all Protectorelays. For Type R100A used with A.C., a Series 10 limiting device is optional and can be used between the thermostat and the control.

IMPORTANT - After the burner is installed be sure to check all controls for shorts, defects in wiring, and for proper operation. It is recommended that these checks be made by actual burner operation.

TESTING AND ADJUSTING ALL TYPES

THE SAFETY SWITCH - The Safety Switch should be tested by turning off the oil supply to the burner and starting the burner without combustion taking place. After approximately two minutes, the timing of the safety switch, the burner should stop on safety. Wait approximately five minutes for safety switch to cool. Turn on oil supply safety switch button (5-Fig. 3) to start the burner.

CURRENT FAILURE - Current failure can be tested by starting the burner and permitting the control to reach full running position. Then pull line switch momentarily and reset it.

The burner will stop and remain stopped until the stack temperature lowers and the Pyrostat or Protectostat returns to the cold position. The burner should then go through its starting and running cycle automatically.

SCAVENGER PERIOD - The Scavenger period occurs after a normal shutdown of the control, and provides a period in which any unburned gases that may have accumulated between the time of the fire extinguishment and the opening of the Pyrostat contact may be exhausted.

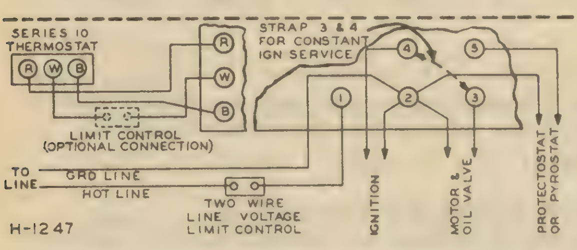


Fig. 1—Connection diagram for Type R100A. Used with A.C. current.

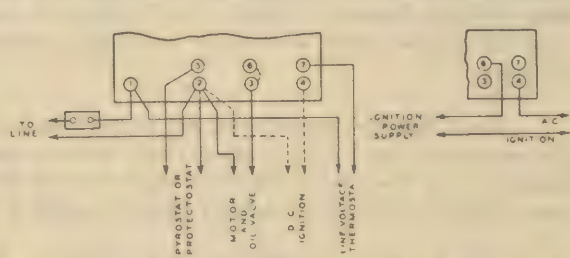


Fig. 2—Connection diagram for Type R100A. Used with D.C. current. When A.C. ignition is used, a converter must be connected to the ignition power supply as shown above.

When the controller breaks contact the coil of Relay No. 1 will drop out and shut off the burner motor. Refer to Figs. 4 or 5. Relay No. 2 will drop out immediately and will make the ignition contact in preparation for a restart. The stack temperatures will drop and the Pyrotectostat or Pyrostat will break its contact, dropping out No. 3 Relay. Relay No. 3 is now in the starting circuit. The burner cannot recycle until the Protectostat or Pyrostat has broken its contact and dropped out No. 3 Relay.

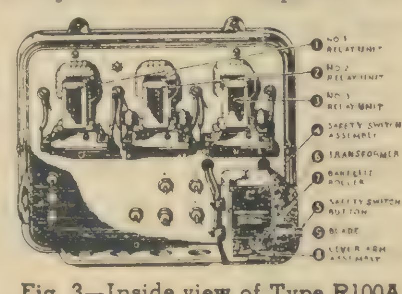


Fig 3—Inside view of Type R100A Protectorelay

FLAME FAILURE - The Protectostat or Pyrostat will respond in case of flame failure. Almost immediately it will break its contact and drop our Relay No. 3. This will stop the burner motor, permitting the current to flow through the heating element of the thermal safety switch, and at the expiration of its timing period it will trip. A

safety shutdown will result, and then it will be necessary to press the safety switch button before the burner can restart.

SERVICE SUGGESTIONS

The cover must be left on the control at all times to protect its parts from dust and mechanical injury.

Do not use oil on any part of the control.

The wiping action of the relay contacts make them self cleaning. However, it is recommended that once each season they be cleaned by drawing a strip of hard finished paper (not newspaper) between the contacts while in a closed position. Be sure no paper shreds remain between the contact points.

The contacts may turn black with service but it is not necessary to remove this discoloration.

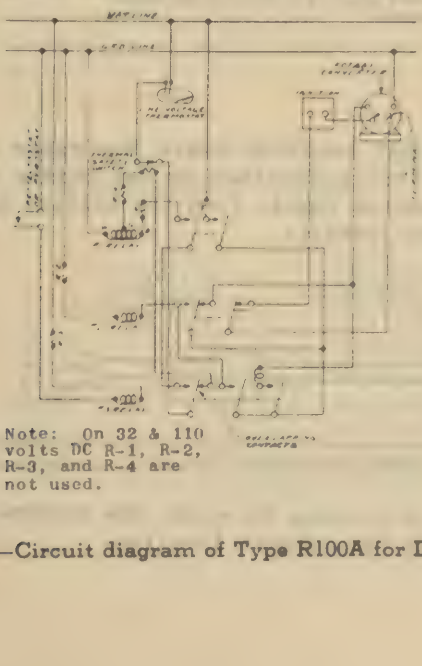
In case of failure, check the thermal safety switch by depressing and releasing the safety switch button to see if the failure is a result of the safety shutdown.

Pushing No. 1 relay armature closed by hand, to check the line voltage circuit, should start the burner motor. If the burner motor fails to start and the power supply is alright, check the circuit from the protectorelay to the motor, and inspect the motor itself.

If No. 1 relay fails to close automatically, but remains closed when pushed in by hand, a break or poor connection in the blue wire or a poor blue contact is indicated.

The chattering operation of No. 1 relay with the thermostat in correct adjustment, indicates either a break in the red wire, interchanging of the blue with either the red or white wire, or a short between the blue and white wires. The thermostat wiring must be connected color to color to the relay terminals.

Short circuits in low voltage wiring are sometimes caused by bare wires coming together, but more often by staples being driven in too tightly and cutting through



Note: On 32 & 110 volts DC R-1, R-2, R-3, and R-4 are not used.

Fig. 4—Circuit diagram of Type R100A for D.C.

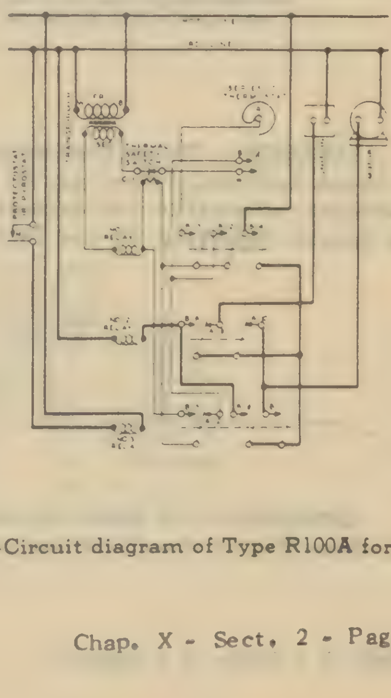


Fig. 5—Circuit diagram of Type R100A for A.C.

the insulation of the cable. However, trouble within the thermostat cable is rare, and most wiring difficulties can be traced directly to carelessness in making connections properly and securely at the instrument.

INSTALLATION INSTRUCTIONS

L104, L204, L404, L604 PRESSURETROLS - L411 VACUUMSTAT - The Pressuretrol is used primarily as a high limit control on steam heating systems, but may be used with air, liquid or gases that are not chemically injurious. Variations in pressure causes the bellows in the Pressuretrol to tilt a mercury switch which in turn makes or breaks an electrical circuit.

PRESSURETROLS—	
Range	Differential
All Types 2 to 50 lbs.	Adjustable 2 lbs. to 12 lbs
All Types 5 to 150 lbs.	Adjustable 2-5 lbs. to 16 lbs.
All Types 10 to 300 lbs.	Adjustable 5 lbs. to 40 lbs.
VACUUMSTATS—	
All Types 22″ vac. to 35 lbs.	Adjustable 4 1/2″ merc. or 2 1/2 lbs. to 30 lbs.

The Vacuumstat is similar in construction to the Pressuretrol except that it is designed for operation in both pressure and vacuum ranges. It should never be used however, unless the heating system is equipped with a vacuum pump.

SPECIFICATIONS

TYPES—

L104A—Breaks contact on pressure rise (Ser. 10).
L104B—Breaks contact on pressure drop (Ser. 10).
L204A—Closes valve or draft damper on pressure rise (Ser. 20).
L404A—Breaks contact on pressure rise (Ser. 40).
L404B—Breaks contact on pressure drop (Ser. 40).
L411A—Breaks contact on pressure rise (Ser. 40).
L411B—Breaks contact on pressure drop (Ser. 40).
L604A—S.P.D.T. (Series 60). See Fig. 6.

ADJUSTMENT—External screws. Knurled adjustment knob available at extra cost.

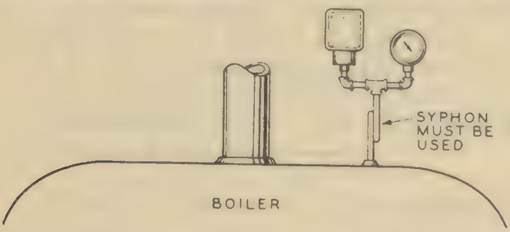
ELECTRICAL RATING — L104A, L104B, L204A: Low voltage.
L404A, L404B, L411A, L411B: 10 amps 110 volts, 5 amps. 220 volts, 1 H.P. R.I., 1/2 H.P. S.P., 1/4 H.P. D.C.
L604A: 1 amp. 110 volts, 1/2 amp. 220 volts, 1/20 H.P. R.I. S.P. and D.C.

MOUNTING MEANS—1/4″ pipe threads.

CASE DIMENSIONS—Height 3 7/8″, width 3 1/2″, depth 2 1/2″.

WHEN ORDERING SPECIFY:
1. Type Number.
2. Range.
3. Knurled adjusting knob (for pressuretrols) if desired.

LOCATION - These controllers are designed for location above the water line in steam boilers. They may be mounted in the fitting provided by the boiler manufacturer, alongside the pressure gauge, at a location remote from the boiler, or in the special mounting of the C402 and C602 Low-Water Cutoffs.



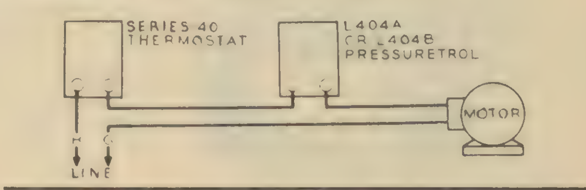


Fig. 1—L404A, B or L411A, B with 2 wire circuit.

IMPORTANT - If there is no pressure gauge or fitting to mount the controller in, consult your local boiler representative as to the correct location.

MOUNTING - General--These Pressuretrols and Vacuumstats are provided with a 1/4" iron pipe size female fitting.

A syphon must always be connected between the controller and the boiler. The loop of the syphon must be looped towards the front or back of the instrument, never towards the side.

When making pipe connections use pipe dope or white lead to seal the joints, but use it sparinly as any excess amount of pipe dope may clog up the small hole in the controller fitting and thereby prevent it from operating properly.

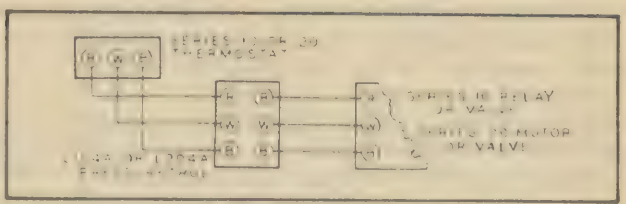


Fig. 2—L104A or L204A connection diagram.

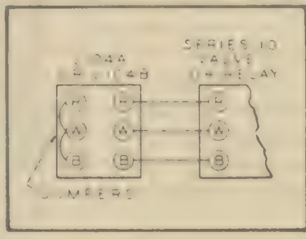


Fig. 3—L104 Pressuretrol used as a controller.

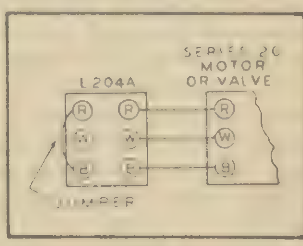


Fig. 4—L204A Pressuretrol used as a controller.

Located inside on the back of the case is a leveling indicator. Mount the controller so the indicator hangs freely and with the point directly over the mark on the back of the case.

PRESSURE GAUGE MOUNTING - To mount the controller beside the pressure gauge, it if first necessary to remove the pressure gauge. Next install a tee and mount the controller and pressure gauge, one on each side of the tee. Then connect a syphon between the tee and the boiler. Level up the controller.

BOILER MOUNTING - If it is not convenient to mount the controller adjacent to the pressure gauge, mount at the location in the boiler recommended by the boiler manufacturer. All that is necessary for this type of mounting is to screw a syphon into the boiler. Then screw the controller directly to the syphon. Be sure it is level.

REMOTE MOUNTING - On all installations where excessive vibrations are encountered, the controller may be mounted remotely from the boiler on a solid mounting with a suitable piping connection between. Located remotely from the boiler, they must be installed at a slightly higher level than when mounted as shown in the installation diagram and the piping must be properly pitched to drain all condensation back into the boiler.

IMPORTANT - Be sure that a syphon is used at one end of the piping and that the controller is properly leveled.

SETTING
L411 SCALE MARKINGS

MAIN SCALE	
H--35	lbs. Pressure
--20	lbs. Pressure
--10	lbs. Pressure
O-- 0	lbs. Pressure
--10	Inches Vacuum
L-- 22	Inches Vacuum

DIFFERENTIAL SCALE	
H--31	lbs. Pressure
G--27 5/8	lbs. Pressure
F--24	lbs. Pressure
E--20½	lbs. Pressure
D--16¾	lbs. Pressure
C--13½	lbs. Pressure
B-- 9	lbs. Pressure
A-- 4¾	lbs. Pressure

DIRECT ACTING TYPES ("A" MODELS) - In these models, the "cut-in" pressure setting (7-Fig. 5) plus the differential setting (9) equals the "cut-out" pressure. That is, in the L104A and L404A controllers, if indicator (7) were set for 10 lbs. and differential indicator (9) set for 2 lbs., the mercury switch would "make" when the pressure dropped to 10 lbs. and would "break" when the pressure rose to 12 lbs. In the L204A and L604A models, the starting contacts (R to B) would "make" when the pressure dropped to 10 lbs. and the stopping contacts (R to W) would "make" when the pressure rose to 12 lbs.

TO SET - 1. Turn the screw (1) until the indicator (7) points to the desired cut-in pressure.

2. Turn the screw (2) until indicator (9) points to the desired differential between cut-in and cut-out pressures.

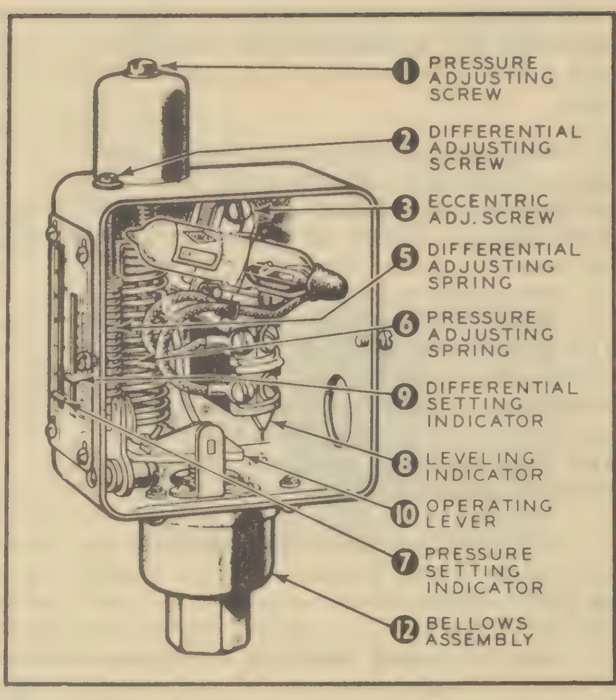


Fig. 5—Type L404A Pressuretrol. Other types and Vacuumstats are similar except for type of mercury switch and arrangement of wiring terminals as shown in Fig. 6.

REVERSE ACTING TYPES ("B" MODELS) - In these models, L411B, L104B, and L404B, the cut-out pressure setting (7) plus the differential setting (9) equals the cut-in pressure. If for example, the indicator (7) were set for 10 lbs. and the indicator (9) were set for 2 lbs., the mercury switch would break when the pressure dropped to 10 lbs., and would make when the pressure rose to 12 lbs.

TO SET - 1. Turn the screw (1) until indicator (7) points to desired cut-out pressure.

2. Turn the screw (2) until indicator (9) points to the desired differential between the cut-out and cut-in pressures.

TESTING AND ADJUSTING

After the controller has been installed, wired, and set it should be tested by raising and lowering the pressure to make sure that it operates the controlled devices properly. If the cut-in and cut-out points do not agree with the pressure gauge on the boiler, the scale plate on the controller may be moved slightly up or down until it agrees with the pressure gauge.

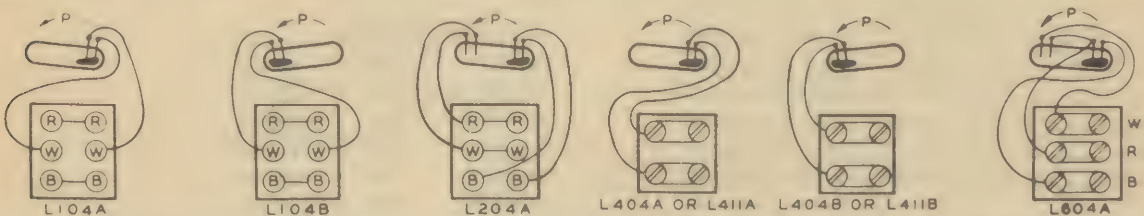


Fig. 6—Internal wiring. Letter "P" indicates rotation of switches on pressure rise.

Note: The controllers are carefully calibrated at the factory with an accurate gauge. Do not rely entirely on the inexpensive pressure gauges when checking the operation of the controller.

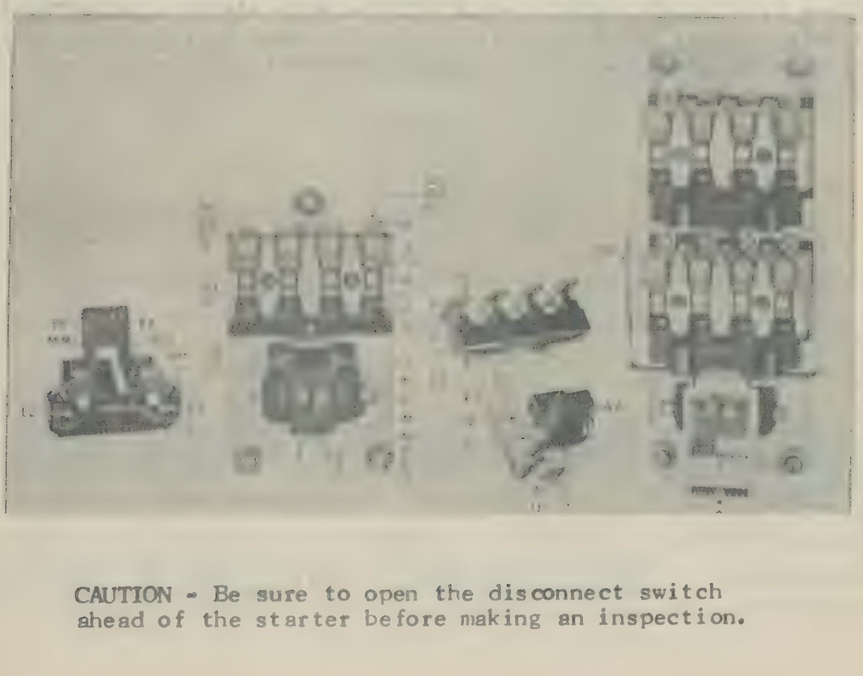
MERCURY SWITCH ADJUSTMENT - If the operating differential of the controller is considerably smaller than that for which the indicator is set, the mercury switch may be out of adjustment. This sometimes occurs when a broken switch is replaced. Before making any adjustments however, be sure that the difficulty is not due to the controller being "off level". Note the level indicator (8).

The adjustment may be checked as follows: Set the differential indicator (9) approximately at mid-scale, and the pressure indicator (7) to the low end of the scale. With no pressure on the boiler, press down on the left hand end of the operating lever (10) until it is about midway between its upper and lower stops and just touches the differential lever. This movement should not cause the mercury to change ends in the switch. Further downward pressure on the operating lever will force it to the lower stop carrying the differential lever with it and will cause the switch to tilt and shift the mercury. Now, allow the operating lever to slowly return to midway between stops and note that the mercury should not shift its position. Allow the operating lever to return to its upper stop and the switch should tilt back to its original starting position.

If the switch does not operate in this manner, turn the eccentric screw (3) slightly to the right or left as necessary and re-check as outlined above.

TO REPLACE MERCURY SWITCH - Note the arrangement of the contacts and flexible leads and make sure that they are in proper position when the new switch is in place. Use the point of a knife to pry the switch clip loose from the mercury switch--never attempt to break it loose with your fingers. Wrap two layers of friction tape around the switch to take the place of the ambroid cement before placing the switch in the clip. Check the adjustment as outlined above.

SIZE O-A.C. MAGNETIC CONTACTORS AND STARTERS - TYPE R



CAUTION - Be sure to open the disconnect switch ahead of the starter before making an inspection.

ACCESSIBILITY - Essentially all replaceable parts may be made accessible by taking out the two screws F on front of armature lever guide X and removing the entire movable assembly as shown in the photograph on the preceding page.

CONTACTS - All contacts are silver and are not harmed by discoloration and slight pitting. *Do not file them* as dressing of these contacts merely wastes contact material. Replacement is necessary only when the silver has worn thin.

To inspect the *normally open contacts*, first take out screws F and remove the entire movable assembly. The movable contact finger A is removed from the contact guide Z by tilting it edgewise against finger spring B. The stationary contacts C and D are released by removing screws H.

To inspect the *normally closed contacts*, the entire movable assembly is removed as described above. The stationary contacts C and D are removed by taking out screws H, which releases the movable contact A and contact spring B.

MAGNET COIL - To remove the magnet coil K, take out entire movable assembly (see paragraph "Contacts"), disconnect wires from terminals L, squeeze the ends of the coil holder S together and slide the coil off the magnet frame.

THERMAL RELAYS - For illustration purposes the thermal overload relay blocks have been removed from their usual positions on either side of the steel base plate and a single cutaway block EE is shown.

The thermal unit does not deteriorate from operation. Continued overcurrent through the heating element raises its temperature, finally melting the alloy and permitting the ratchet wheel to rotate. The latch engaging the ratchet wheel is then released, allowing the relay contacts in series with the magnet coil of the cibtactor to snap open, thus disconnecting all lines to the motor. *Allow a few moments for the melted alloy to solidify before presetting the relay.*

ELECTRIC INTERLOCK - Any contact may be used for electrical intrelocking purposes, and may be either normally open or normally closed. For this reason, the catalog listing of *starters*, when naming a *three* pole starter, is actually supplied with a *four* pole contact block to give a normally open interlocking contact. Catalog listing of *contactors* names the actual number of poles supplied.

ORDERING INSTRUCTIONS: Specify quantity, catalog number and description of part, giving complete nameplate data of the device. For example: 3—26AP 1861-G3 movable contact fingers for starter with serial No. 568723-2007-S3-B60.

PARTS LIST

Photo Identification (Page 1)	Description	Catalog Number	NUMBER REQUIRED 2 Poles	3 Poles	4 Poles	5 Poles	6 Poles	7 Poles	8 Poles
A	Movable Contact Finger	26AP 1861-G3	2	3	4	5	6	7	8
B	Contact Spring—2 to 4 Poles	26AP 1861-X23	2	3	4	..	..	..	..
B	Contact Spring—5 to 8 Poles	26AP 1861-X10	..	..	..	5	6	7	8
C	Stationary Contact—Front Normally Open (Rear Normally Closed)	26AP 1861-G1	2	3	4	5	6	7	8
D	Stationary Contact—Rear Normally Open (Front Normally Closed)	26AP 1861-G2	2	3	4	5	6	7	8
E	Terminal Clamp	26AP 1861-X15	6	9	12	15	18	21	24
F	Round Head Iron Machine Screw	26AP 8-32x5/16"	8	11	14	17	20	24	28
G	Lock Washer #8	26AP PM20-#8	6	9	12	15	18	21	24
H	Filister Head Iron Machine Screw	26AP 8-32x1/4"	4	6	8	10	12	14	16
I	Contact Block, 2 and 3 Pole	26AP 1861-B3-X1	1	1	..	..	2	1	..
I	Contact Block, 4 Pole	26AP 1861-B1-X1	..	..	1	..	..	1	2
I	Contact Block, 5 Pole	26AP 1861-B2-X1	..	..	..	1	..	..	..
J	Round Head Iron Machine Screw	26AP 6-32x1 1/4"	1	1	1	1	1	1	1
K	Magnet Coil	See Tables Below	1	1	1	1	1	1	1
L	Magnet Coil Term. Screw 6-32x1/4"	26AP PM11-1	2	2	2	2	2	2	2
M	Magnet Frame Assembly	26AP 1861-D4-G1	1	1	1	1	1	1	1
N	Rubber Grommet	26AP PM66-763	3	3	3	3	4	4	4
O	Flanged Spacer	26AP 1861-X17	3	3	3	3	4	4	4
P	Everlock Washer	26AP PM73-#10	3	3	3	3	4	4	4
Q	Mounting Screw	26AP 1861-X16	3	3	3	3	4	4	4
R	Armature Guide	26AP 1861-X8	2	2	2	2	2	2	2
S	Coil Holder	26AP 1861-X7	2	2	2	2	2	2	2
T	Tail Spring	26AP 1861-X12	1	1	1	1	1	1	1
U	Hinge Plate	26AP 1861-D5-X1	1	1	1	1	1	1	1
V	Hinge Pin	26AP 1861-X9	1	1	1	1	1	1	1
W	Armature Lever Assembly	26AP 1861-D6-G1	1	1	1	1	1	1	1
X	Armature Lever Guide	26AP 1861-C4-X1	1	1	1	1	1	1	1
Y	Yoke Bar, 2 and 3 Pole	26AP 1861-C5-X2	1	1	..	..	2	1	..
Y	Yoke Bar, 4 Pole	26AP 1861-C1-X1	..	..	1	..	..	1	2
Y	Yoke Bar, 5 Pole	26AP 1861-C5-X1	..	..	..	1	..	..	..
Z	Movable Contact Guide	26AP 1861-X1	2	3	4	5	6	7	8
AA	Armature	26AP 1861-D3-G1	1	1	1	1	1	1	1
BB	Hexagon Iron Nut 6-32	26AP PM21-6-32	1	1	1	1	1	1	1
CC	Lock Washer #6	26AP PM20-#6	2	2	2	2	2	2	2
DD	Bracket, 6 and 7 Pole	26AP 1861-D15-X1	..	..	..	..	2	2	..
DD	Bracket, 8 Pole	26AP 1861-D15-X2	..	..	..	..	..	..	2
NN	Rear Terminal	26AP 1861-X3	2	3	4	5	6	7	8
OO	Rear Terminal Screw	26AP 8-32x3/8"	2	3	4	5	6	7	8
PP	Front Terminal	26AP 1861-X4	2	3	4	5	6	7	8
QQ	Front Terminal Screw	26AP 8-32x5/8"	2	3	4	5	6	7	8
RR	Front Terminal Iron Washer	26AP IW 8A	2	3	4	5	6	7	8
SS	Movable Contact Guide Mtg. Screw	26AP 4-36x3/8"	2	3	4	5	6	7	8
TT	Movable Contact Guide Lock Washer	26AP PM20-#4	2	3	4	5	6	7	8
UU	Contact Block Mtg. Screw	26AP 8-32x2 1/4"	2	2	2	2	4	4	4
	Overload Relay Block Assembly		For One Assembly Only						
EE	Reset Slider and Latch Assembly	26AP 2037-D5-G1	1						
FF	Reset Latch Spring	26AP 1359-X10	1						
GG	Round Head Iron Machine Screw	26AP 10-24x3/8"	2						
HH	Lock Washer	26AP PM20-#10	2						
II	Brass Washer	26AP BW #10	2						
JJ	Binder Head Brass Mach. Screw #10-24x5/16"	26AP 527810	2						
KK	Terminal and Contact Finger Assembly	26AP 2037-G2	1						
LL	Contact Finger Assembly	26AP 2037-G1	1						
MM	Back Plate	26AP 2037-D18-X1	1						

MAGNET COILS

Frequency	2 to 4 Poles Inclusive: 110 Volts	208-220 Volts	440 Volts	550 Volts	Double Voltage Coils 2 to 4 Poles Inclusive: 110/220 Volts	220/440 Volts
25	26AP 1861-S1-R32B	26AP 1861-S1-R35B	26AP 1861-S1-R38B	26AP 1861-S1-R39B	26AP 2050-S7-DR35B	26AP 2050-S7-DR38B
50	26AP 1861-S1-R30B	26AP 1861-S1-R33B	26AP 1861-S1-R36B	26AP 1861-S1-R37B	26AP 2050-S7-DR33B	26AP 2050-S7-DR36B
60	26AP 1861-S1-R29B	26AP 1861-S1-R32B	26AP 1861-S1-R35B	26AP 1861-S1-R36B	26AP 2050-S7-DR32B	26AP 2050-S7-DR35B

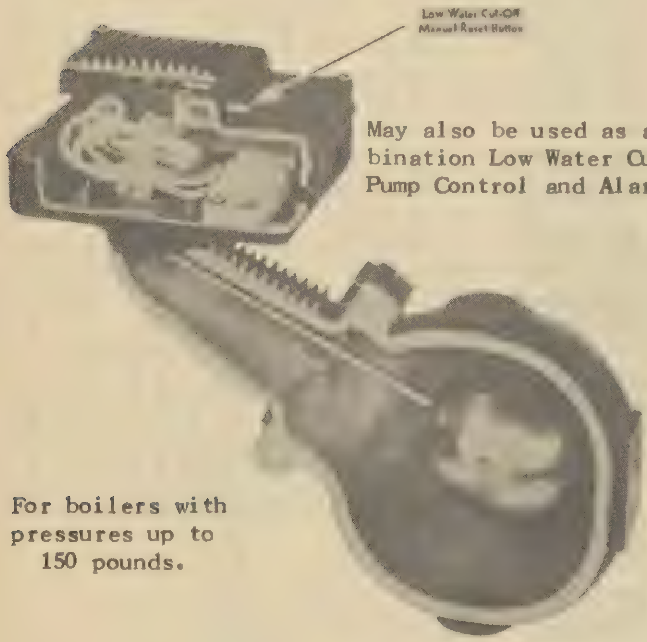
Frequency	5 to 8 Poles Inclusive: 110 Volts	208-220 Volts	440 Volts	550 Volts	Double Voltage Coils 5 to 8 Poles Inclusive: 110/220 Volts	220/440 Volts
25	26AP 1861-S1-R31C	26AP 1861-S1-R34C	26AP 1861-S1-R37C	26AP 1861-S1-R38C	Not Supplied for 5 to 8 Poles	
50	26AP 1861-S1-R30B	26AP 1861-S1-R33B	26AP 1861-S1-R36B	26AP 1861-S1-R37B		
60	26AP 1861-S1-R29B	26AP 1861-S1-R32B	26AP 1861-S1-R35B	26AP 1861-S1-R36B		

McDONNELL NO. 150-M HIGH PRESSURE LOW WATER CUT-OFF

The McDonnell No. 150-M has proved in hundreds of installations to be the most satisfactory solution to the problem of applying low water protection to boilers operating at pressures up to 150 lbs.

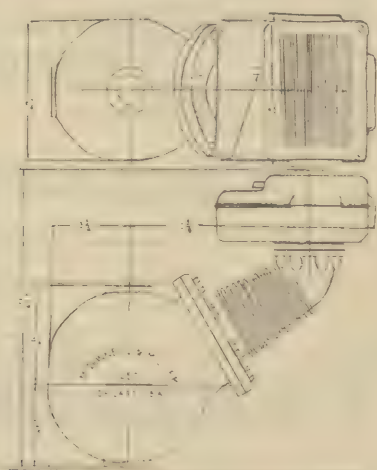
The success of the No. 150-M is based squarely on the fact that it was carefully developed to stand up under the arduous conditions imposed by high pressures and temperatures. The body is a rugged, dense casting with heat radiating fins for dissipating heat from the float chamber.

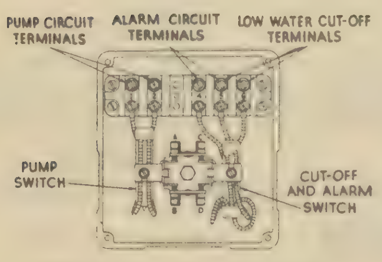
All operating parts are isolated from the steam and hot water zone, and the temperature surrounding them is further reduced by radiating fins on the housing and proper ventilation. Packing--always a source of trouble under high pressure and temperature conditions--is totally eliminated by a bellows of extra heavy construction. The float is heavy monel of welded construction capable of withstanding pressures far beyond the rating of the No. 150-M.



May also be used as a combination Low Water Cut-Off, Pump Control and Alarm

For boilers with pressures up to 150 pounds.





Electrical ratings are as follows: As pump control or low water cut-off: A.C., 1 hp., 110-220 volts; D.C. 1/4 hp., 115-230 volts. As low water alarm: 1 amp., 110 volts both A.C. and D.C.

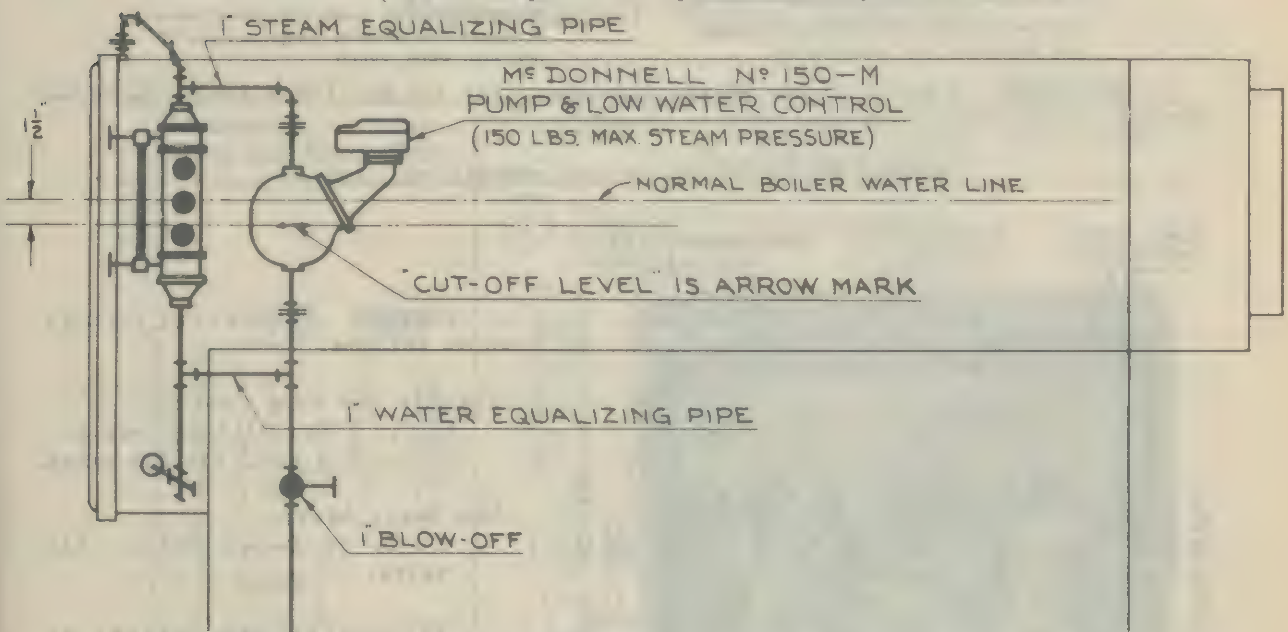
Typical of the many steps that have been taken to make the No. 150-M equal to high temperatures is the beaded porcelain insulation on the lead wires to the switches. This type of insulation is impervious to high temperature and provides ideal flexibility for these connections.

In addition to the low water cut-off and low water alarm switch, an added switch is provided at no extra cost in the No. 150-M, so that the No. 150-M may be used as a combined low water cut-off and pump control. Five terminals are provided, as diagrammed above, so that the No. 150-M can be wired as a low water cut-off, a pump or electric valve control, a low water alarm, or any combination of these functions.

The two switches used in the No. 150-M are specially designed for high temperature service and their cut-off and cut-in points are easily adjustable to meet individual requirements. The pump control switch closes on a minimum drop of 3/4" in the boiler level and can be adjusted to close at any greater drop within the range of practical requirements. The low water cut-off switch can also be adjusted to meet individual requirements.

As a low water cut-off, the No. 150-M offers a dependable means of stopping the burner whenever the water level falls to the danger zone. When used as a combined low water cut-off and pump control, it adds the convenience of automatic water feeding and makes the control of the boiler water level entirely automatic. Typical applications of the No. 150-M are diagrammed on this page.

HOW TO INSTALL THE McDONNELL NO. 150-M
Low Water Cut-Off -- Pump Control -- Low Water Alarm
(For steam pressures up to 150 lbs.)



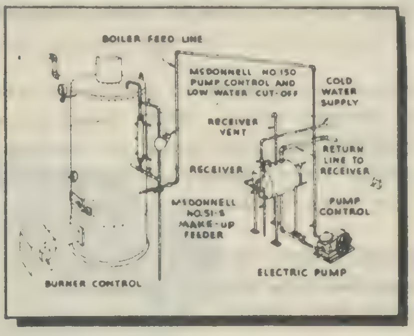
WHEN USED AS A LOW WATER CUT-OFF - Arrow mark on body casting of No. 150-M is burner cut-off level. Install control so arrow mark will be 1½" to 2" below normal boiler water level, but never lower than 1/4" of water in gauge glass. "On" level is 3/4" above "off" level. See diagram above for installation and following page for wiring diagram.

WHEN USED AS PUMP CONTROL - Pump "cut-off" level is 1½" above arrow mark on body of No. 150-M (factory setting). Install control so arrow mark will be 1½" below normal water level of boiler. Pump "on" level (factory setting) is 3/4" below "off" level. See diagram above and following page covering wiring.

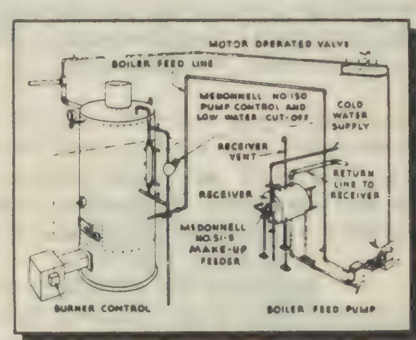
TYPICAL APPLICATIONS OF McDONNELL NO. 150-M AS LOW WATER CUT-OFF AND COMBINED LOW WATER CUT-OFF AND PUMP CONTROL - Terminals are provided for the installation of a low water alarm as covered on separate wiring diagrams.

TEST THE NO. 150-M BEFORE TURNING IT OVER TO OPERATOR.

This can be easily done by opening the blow-off, valve, causing the water line to drop in the float chamber. As the float drops the pump circuit (if used) will first close, then, on a further drop, the cut-off circuit will open and the alarm circuit will be closed.



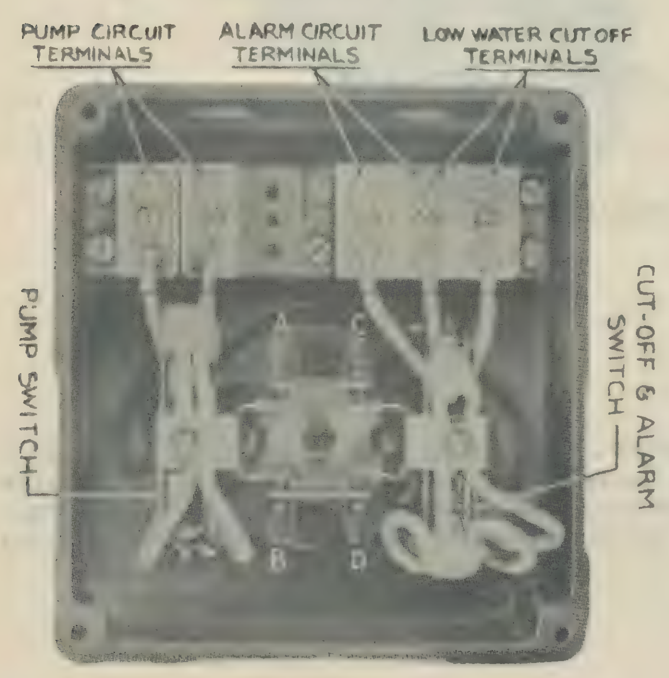
McDonnell 150-M controlling electric pump and providing low water cut-off.



McDonnell 150-M controlling motor valve in supply line to steam pump and provid ing low water cut-off.

IMPORTANT - Impress on the boiler attendant that the No. 150-M should be blown down at least once a month.

WIRING INSTRUCTIONS FOR McDONNELL NO. 150



CAUTION - Electrical ratings are as follows:

Cut-off and Pump Control:
A. C., 1 Hp., 115-220 volts.
D. C., 1/4 Hp., 115-230 volts.

Low Water Alarm:
A. C. or D. C. 1 Amp. 110 volts.

With polyphase motors, or where motor exceeds ratings given above, wire switches of No. 150 into pilot control circuit of starter or relay as shown on following page.

THE CHICAGO AUTOMATIC INJECTOR

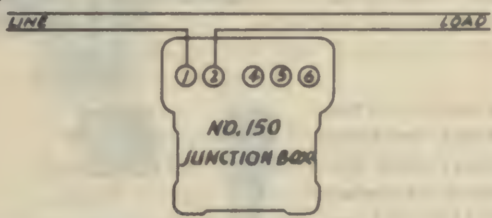
INSTRUCTIONS FOR ATTACHING AND OPERATING - The Chicago Automatic Injector, as its name implies, is fully automatic. It automatically delivers water constantly to the boiler. It is the outstanding Injector from standpoint of performance, durability and simplicity of operation.

TO ATTACH - Injector must be placed in a vertical position.

Steam- Take steam from highest possible point in boiler, and place a globe valve close to the Injector.

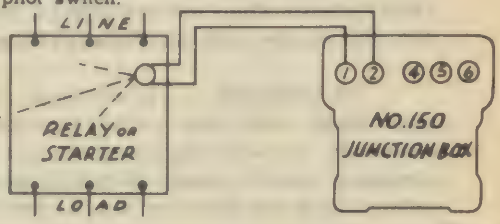
Use These Wiring Diagrams for Pump Control Circuit Only

1 For pump motors 1 Hp. single phase or less, or D.C. ¼ Hp. or less, wire as main line switch.



2 For polyphase pump motors or motors of greater than switch capacity (see ratings listed above) wire switch as pilot switch.

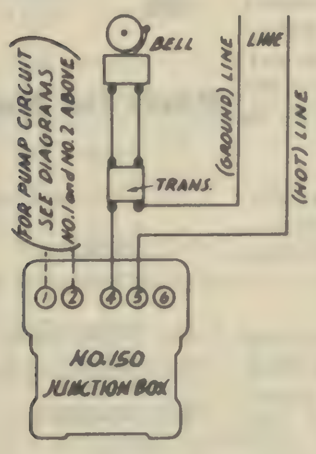
NOTE: In some cases it saves time if the manufacturer of starter or relay is consulted for correct wiring into pilot circuit.



Alarm Circuit Wiring Diagrams

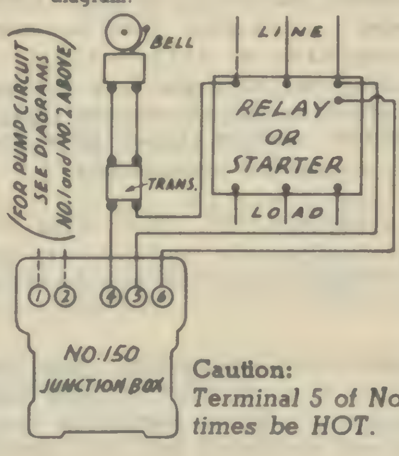
Combination of Pump Control and Alarm Only

5



Combination of Pump Control, Low Water Cut-Off and Alarm

7 Where burner motor is or must be controlled by relay or starter, follow this diagram:



Wire to Terminal (5) of Junction Box of McDonnell No. 150 must always be hot and connected into line ahead of all control stations.

Wire from Terminal 6 must return to starter to resume circuit through control stations.

Caution:
Terminal 5 of No. 150 must at all times be HOT.

Before connecting, blow out steam pipe thoroughly.

Supply - This connection must be absolutely tight, and pipe line should be as straight as possible. Place globe balve in suction line close to the Injector.

See that the stem of this valve is packed tight.

If the Injector is to work on a very long lift, it is better to use the next larger size of pipe and reduce next to the Injector coupling.

Delivery - This pipe line should be as straight as possible and check valve should be placed at least two feet from the Injector.

Overflow - The pipe screwed into this connection should be short, and when discharging into a reservoir must never be carried below the surface of the water.

TO OPERATE - First open wide the valve in supply pipe, then open wide the valve in steam pipe. When working on long lifts it is well to open steam valve *slowly*, but continue the movement until valve is fully open. Regulate the amount of water delivered to boiler by throttling valve in suction pipe.

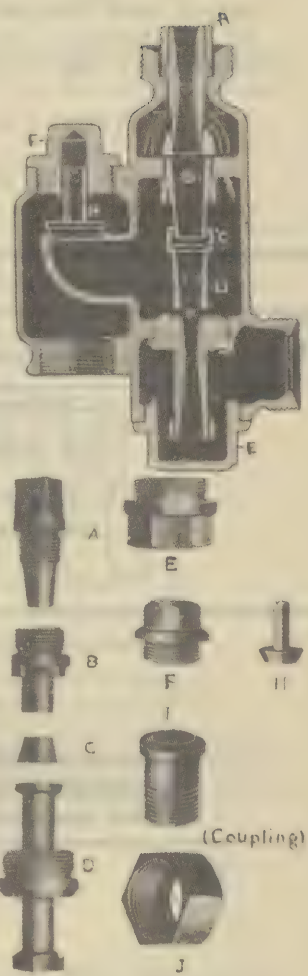
NON-LIFTING - It is very convenient to place two valves in the water supply line, one as shown in the cut and one about two feet from this valve. Then when the valve next to the Injector has been regulated to supply the proper amount of water, its adjustment can be left undisturbed and the additional valve can be used for operating the Injector. This is particularly valuable when the pressure in water line varies, as it tends to keep the amount flowing to the Injector constant.

Open valve in water supply line first, then open valve in steam supply line. If water continues to flow from overflow after steam valve is opened it indicates that the proper amount of water is not being supplied to Injector. If the water issuing from overflow is very hot it shows that Injector is not being supplied with sufficient water; if comparatively cool, too much water is being supplied, and in either case the valve in water supply line must be regulated accordingly.

TO CLEAN - Remove barrel cap (E). This will expose the end of forcing tube (D), which may be removed with an ordinary wrench. This will give free access to the interior of the Injector.

It is frequently possible to thoroughly clean Injector by removing barrel cap (E) and forcing tube (D) and blowing full head of steam through Injector. Before replacing forcing tube, see that interior walls and passages are free from dirt and scale.

HOW TO ORDER REPAIR PARTS - In ordering parts for repairs,



Parts for Repairs

A—Steam Jet
B—Lifting Tube
C—Ring
D—Forcing Tube
E—Barrel Cap
F—Overflow Cap
H—Overflow Check
I—Union
J—Nut

refer to the cuts and specify the letter of each part wanted, calling them by letter and name. Always state size Injector the repairs are for, and order through your dealer.

All parts are made to standard, and can be ordered for repairs either separately or in sets.

Before Connecting Injector Read These Instructions.

INJECTOR TROUBLES - An injector, like any other piece of mechanism, is designed to work under certain conditions and to be operated in a certain manner, and if so operated will give the user no trouble. It frequently happens, however, that from some cause altogether independent from the injector itself it refuses to work properly, and it is to aid in such cases as this, that we give the following suggestions:

If the injector will not lift water, see that the suction pipe is perfectly tight; see that strainer is free from dirt and that suction pipe is not clogged up; see that overflow has perfectly free opening to atmosphere, and that overflow check is not sticking.

If injector lifts water but throws it all out at overflow, see that delivery pipe is not stopped up with scale and that there is free opening into boiler; examine check, make sure that it is not sticking; see that steam pipe is not clogged up and that Injector is getting its full supply of steam; see that there is no scale or dirt in forcing tube.

If Injector lifts water and forces part of it into the boiler but drips and spits hot water from the overflow, see that suction pipe is tight and freely open to water supply; see that no dirt has worked into the suction chamber. An Injector will also work in this manner if water supply is too hot or if steam pressure is too hot or if steam pressure is too high. If steam pressure is too high for stock injector, write us and we will furnish one on a special range to meet your requirements.

In short, see that all connections to injector are tight; that all pipes are open; that injector is free from dirt and scale and that the work which it has to do is within its range.

To remove incrustations caused by water containing lime or other impurities, place parts for a reasonable time in a bath of mineral oil or diluted muriatic acid, consisting of ten parts of water to two parts of acid.

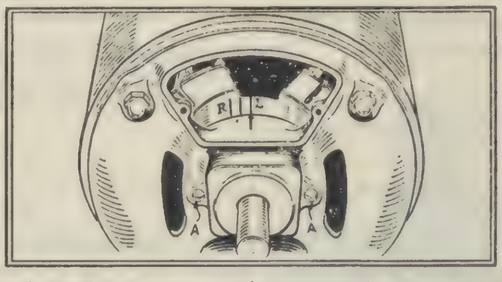
GENERAL INSTRUCTIONS FOR MODEL B-512 MARATHON MOTORS

IMPORTANT - Be sure that the line current, voltage and frequency agree with that stamped on motor nameplate. Check with Power Company if in doubt.

OILING - Model B-512 motors are equipped with ball bearings which are sealed at the factory and require no further lubrication.

MOTOR BRUSHES - The brushes should make a good contact with the commutator and show a polished surface. When brushes spark excessively, the brushes are evidently worn short and should be replaced. When removing brushes, always replace them in exactly the same position. Keep commutator clean with fine sandpaper. Never use emery paper or garnet paper.

HOW TO CHANGE BRUSHES - To change brushes, remove cover as shown in cut, loosen screws "A" one-half turn and rotate ring until brush holder comes to opening. Lift spring from top of brush and lift brush out. Rotate ring either way until other brushes can be removed. When replacing brushes be sure that they bear properly on commutator and that spring rests on top of brush. Keep commutator and brushes clean at all times. Tighten screws "A" and replace cover.



PARTS - When re-ordering parts for the Model B-512 motor, always refer to the OILBILT Unit number *and* parts numbers as shown below:

NAME OF PART	PART NO.	NO. REQUIRED
Armature	5183-5	1
Stator - Complete	13540-1	1
Brush Holder	5020	1
Brushes	5031	2
Brush Springs	5033	4
Front Bracket	5859	1
Rear Bracket	5860	1
Condulet Box	5125	1
Ball Bearings	2260	2
Felt Washer	5038	2
Steel Washer	5040	2

INSTRUCTIONS FOR DISASSEMBLY OF SINGLE IMPELLER PUMPS

Follow operations in order given below and refer to cross section drawing form No. 11-CS-129 for part numbers.

Read Instructions entirely thru before starting to disassemble.

1. Remove cover plate cap screws No. 19A.

2. Loosen adjusting nut set screws No. 29.

3. Remove adjusting nut No. 25.

4. Remove jam nut. No. 24. - Requires socket type wrench.

5. Loosen packing gland eyebolts No. 18A and swing clear of gland No. 17A.

6. Cover plate No. 22 can now be removed - should it stick, tap lightlv around flange edge to loosen or drive flat edged tool (screw driver or chisel) between flanges of cover plate and pump shell at several points around shell. (Be careful or you will break flanges.)

7. Loosen ball bearing lock collar set screw No. 42. Hold lock collar No. 39 with pipe wrench and turn pump shaft with coupling until lock collar loosens up.

8. Loosen coupling set screw No. 4.

9. Pull out shaft and impeller together just enough to remove pump half coupling No. 2 and woodruff key No. 3.

10. Now pull shaft and impeller clear of pump. Impeller can be removed from shaft by loosening set screws No. 10A.

11. Remove cover plate No. 15 by first removing cap screws No. 19.

12. Ball bearings can be removed from bearing arms by pushing same outward from stuffing box side of cover plates after adjusting nuts have been removed.

INSTRUCTIONS FOR REASSEMBLY OF SINGLE IMPELLER TYPE PUMPS

1. Just reverse operations as given for disassembly.

IMPORTANT - Extreme care should be taken to make sure that all inner surfaces of pump shell No. 8 are absolutely free from scale, dirt and burrs. This also applies to cover plate surfaces and in fact, to all surfaces, otherwise the parts will not fit properly and trouble will be encountered in the assembly. Precaution at the start will save time and insure against difficulty. Wash all parts carefully in gasoline.

Make sure Liquid Slingers No. 16 are placed on shaft when reassembling. These slingers prevent the possibility of any liquid, which may leak from the stuffing boxes, from entering the ball bearing and washing out the grease.

Check up on packing in stuffing box. It may have become dried out and hard. If so, renew it with a good grade of braided, graphited and lubricated asbestos packing. Do not pull up too tight on packing glands No. 17 & 17A. Let the pump run in and *always tighten* packing glands when pump is running and then just enough to prevent excessive leakage. A drip of a few drops per minute is highly desirable as this keeps packing from driving out and prevents scoring of pump shaft.

INSTRUCTIONS FOR ADJUSTING IMPELLER CLEARANCE (after assembly)

1. Screw in adjusting nut No. 25 partially. Make sure both adjusting nuts Nos. 25 and 7A are loose before starting the adjustment. Leave adjusting nuts Nos. 5 & 7 slightly loose.

2. Tighten adjusting nut No. 25 sufficiently that shaft will not turn (to try this take hold of coupling and try to rotate). The impeller is now rubbing against cover plate on coupling side of pump.

3. Loosen adjusting nut No. 25 just a fraction of turn or until you can rotate shaft freely. Now tighten up on adjusting nut No. 7A and try to rotate again. If pump turns over freely with no indication of impeller rubbing, the pump is properly adjusted. If rubbing still occurs you can work the two adjusting nuts "back and forth" until pump does rotate freely. Do not tighten up on adjusting nuts too much, just bring up firmly by very light taps of hammer. After proper adjustment has been secured, then lock adjusting nuts by tightening up the adjusting nuts set screws No. 29, located in the bearing arms.

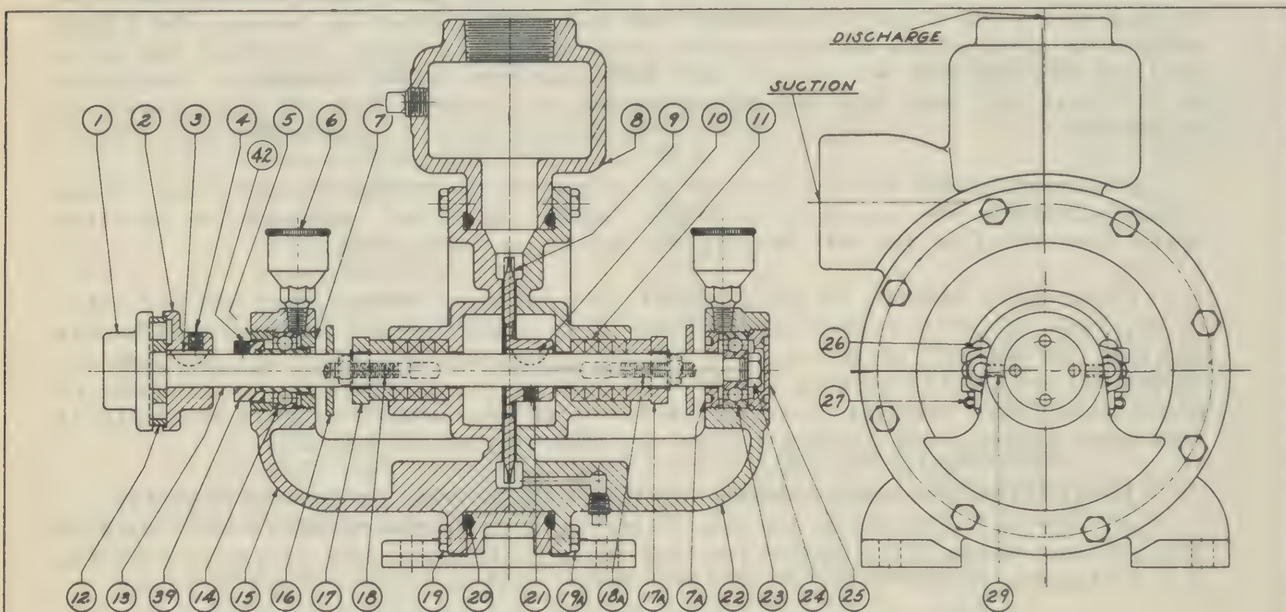
4. It is recommended that impeller adjustment be made with packing removed from pump.

SPECIAL NOTE - When pumping hot liquids, should pump fail to rotate freely due to excessive expansion of casing and shaft, loosen adjusting nuts No. 25 and No. 7A. Now readjust as per preceding instructions at operating temperature.

TO ADJUST AND ALIGN FLEXIBLE COUPLING - Before tightening up coupling set screw No. 4, locate pump half coupling No. 2, by sliding shaft, so that coupling

pins or lugs on pump half coupling does not strike motor half coupling. Leave at least 1/16" clearance. Be sure coupling insert No. 12 is in place.

After complete assembly of pump and motor on base plate, be sure to "line-up" coupling. Failure to do this will cause insert to wear out; also a rumbling noise will be present when pump is running. "Lining-up" can easily be checked by applying a straight edge across the coupling, which must rest evenly on both rims at the top, bottom and sides. Then shims should be placed under pump or motor if necessary to accomplish perfect alignment. See Instruction under heading "Alignment appearing in *Installation* and *Operating Instructions*.



NO.	PART	NO.	PART	NO.	PART
1	COUPLING MOTOR HALF	11	PACKING	21	SETSCREW
2	COUPLING PUMP HALF	12	COUPLING INSERT	22	COVER (RIGHT)
3	COUPLING KEY	13	SHAFT	23	BALL BEARING
4	SETSCREW	14	BALL BEARING	24	JAM NUT
5	ADJUSTING NUT	15	COVER (LEFT)	25	ADJUSTING NUT
6	GREASE CUP	16	WATER SLINGER	26	CLEVIS PIN
7	ADJUSTING NUT	17	GLAND	27	COTTER PIN
8	SHELL	18	EYEBOLT, NUT+WASHER	39	LOCK COLLAR
9	IMPELLER	19	CAPSCREW	29	SETSCREW
10	IMPELLER KEY	20	GASKET	42	LOCK COLLAR SETSCREW

SCALE:	DRAWN BY:
DATE: 1-16-40	11-CS-129

HOW TO ORDER REPAIR PARTS - Order by part name and part number; also give size and serial number of pump found on name plate. It is absolutely necessary to give serial number in order that we can identify the particular model pump for which repairs are wanted.

ACCEPTABLE GREASES FOR BALL BEARING LUBRICATION

The following list of greases is intended for general or normal conditions for ball bearing application, for all speeds normal to the size of bearing as listed in capacity tables and for temperatures from 0° to 180° F.

MANUFACTURER	BRAND
Borne Scrymser	Massed 177
Fiske Bros. Refining Co.	*Pyro Lubricant
Master Lubricants Co.	M32
N.Y. & N.J. Lubricating Co.	S58
N.Y. & N.J. Lubricating Co.	F925
N.Y. & N.J. Lubricating Co.	A29 Special
Standard Oil Company	* Calol

To supplement the above list, the following lubricants are intended for service under abnormally high temperature conditions.

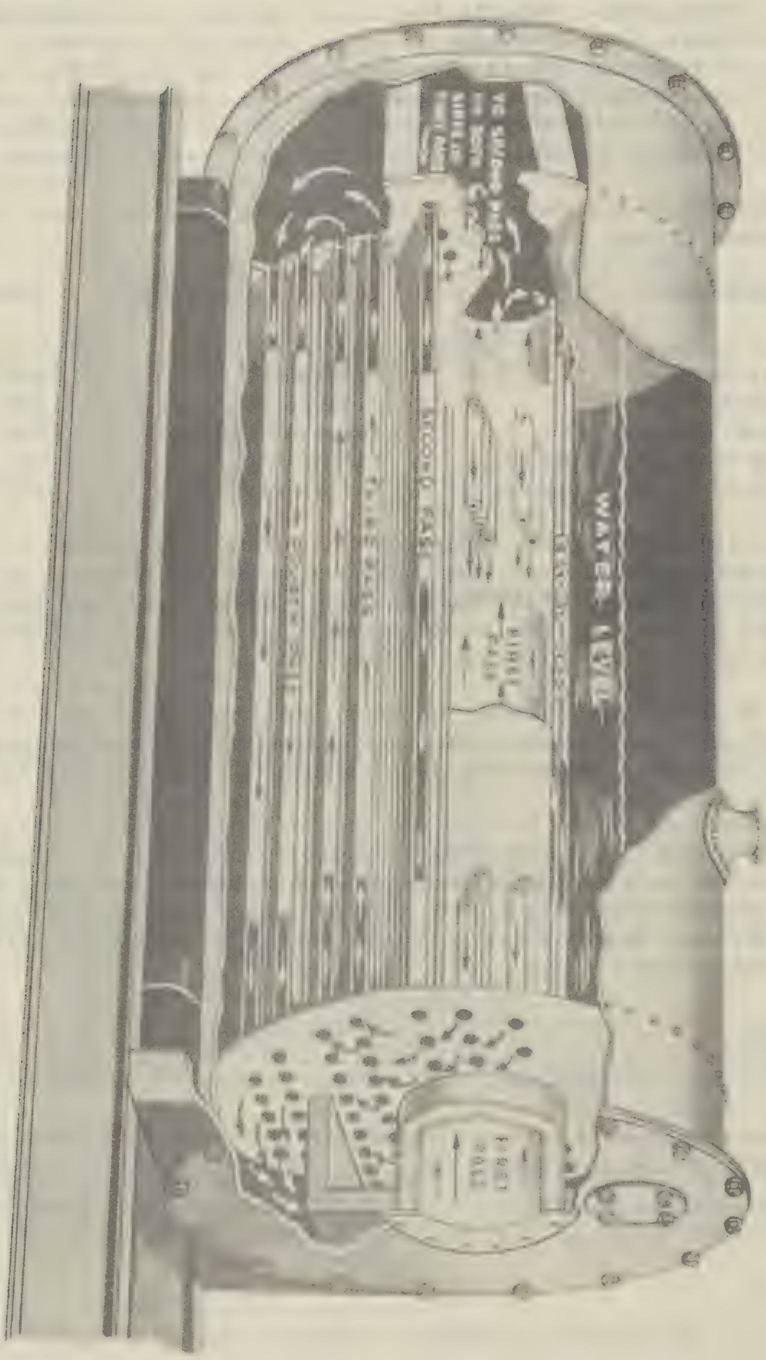
MANUFACTURER	BRAND	TEMPERATURE LIMITS
Texas Company	Marfak #2	150° to 190° F.
Texas Company	Starfak #2	200° to 260° F.
Standard Oil Co.	Superla #6A	200° to 300° F.
Sacony-Vacuum Oil Co.	Gargoyle BRB #4	200° to 300° F.
Fiske Bros. Refining Co.	Lubriplate	Up to 300° F.
Fiske Bros. Refining Co.	Lubriplate #320	300° F. and Above

The above products are suggested for guidance only, subject to the approval of the lubricant manufacturer. They have been selected, however, as a result of meeting rigid test requirements of the ball bearing manufacturers, and because of satisfactory performance in service. All of the above lubricants have national distribution, and, therefore, are readily procurable by the user.

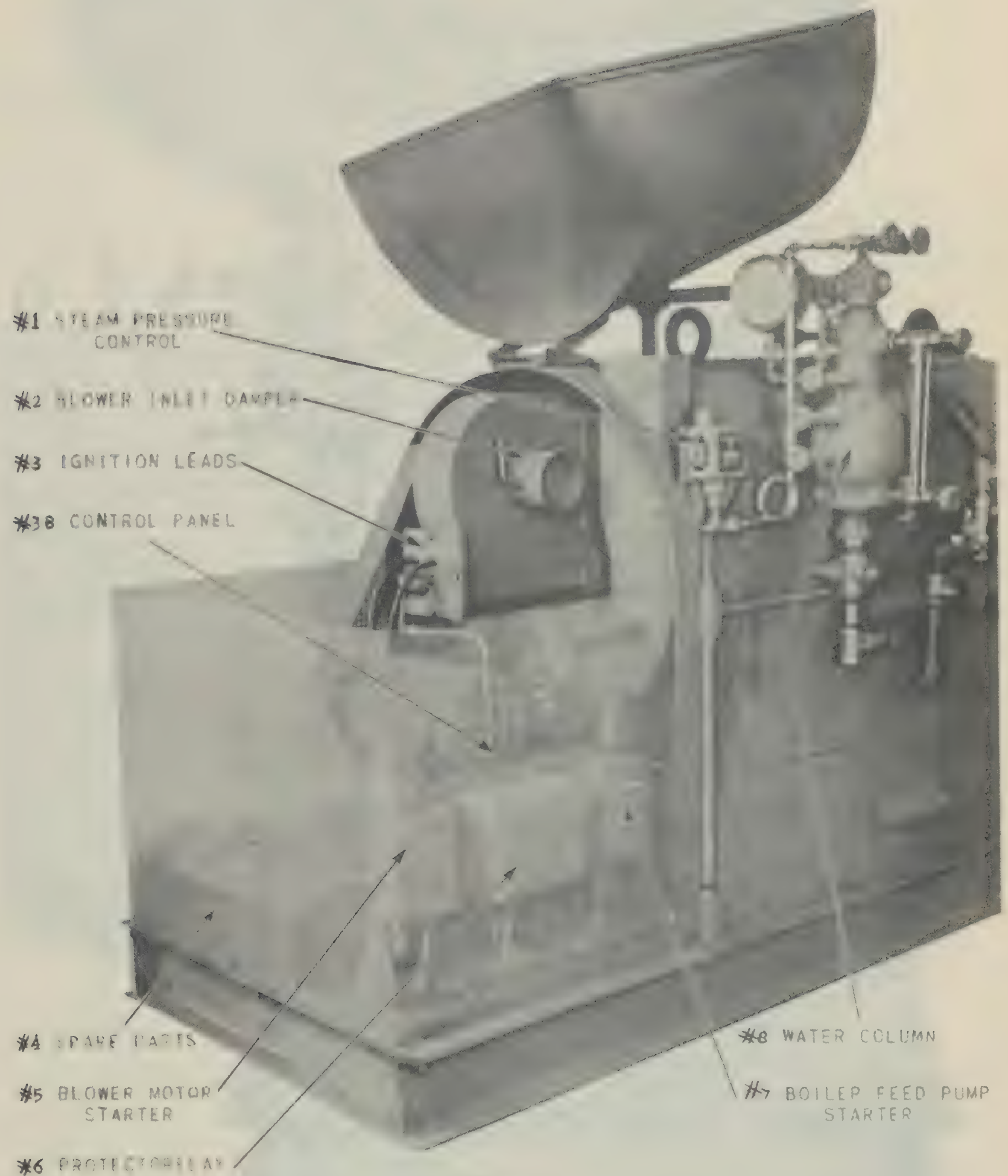
For abnormal conditions, including high temperature, low temperature, high speed applications, wet conditions, etc., special lubrication conditions are encountered and the Fafnir Engineering Dept. should be consulted for recommendation.

The amount of grease used in any housing has a definite relation to shaft speed. An excessive amount of lubricant will cause heating and oftentimes leakage. Too much emphasis cannot be given the importance of keeping grease clean at all times -- free from the contaminating influences of dirt, grit, and any other form of impurity. Unclean lubricant causes a very definite deficiency in the operating life of any ball bearing application.

*These greases have consistency slightly stiffer than No. 2 and from that standpoint, while not objectionable, are not as desirable in the higher speed ranges.



Cribilt
STEAM GENERATING PLANT



#1 STEAM PRESSURE CONTROL
#2 BLOWER INLET DAMPER
#3 IGNITION LEADS
#38 CONTROL PANEL
#4 SPARE PARTS
#5 BLOWER MOTOR STARTER
#6 PROTECTOR RELAY
#8 WATER COLUMN
#7 BOILER FEED PUMP STARTER

Figure 1

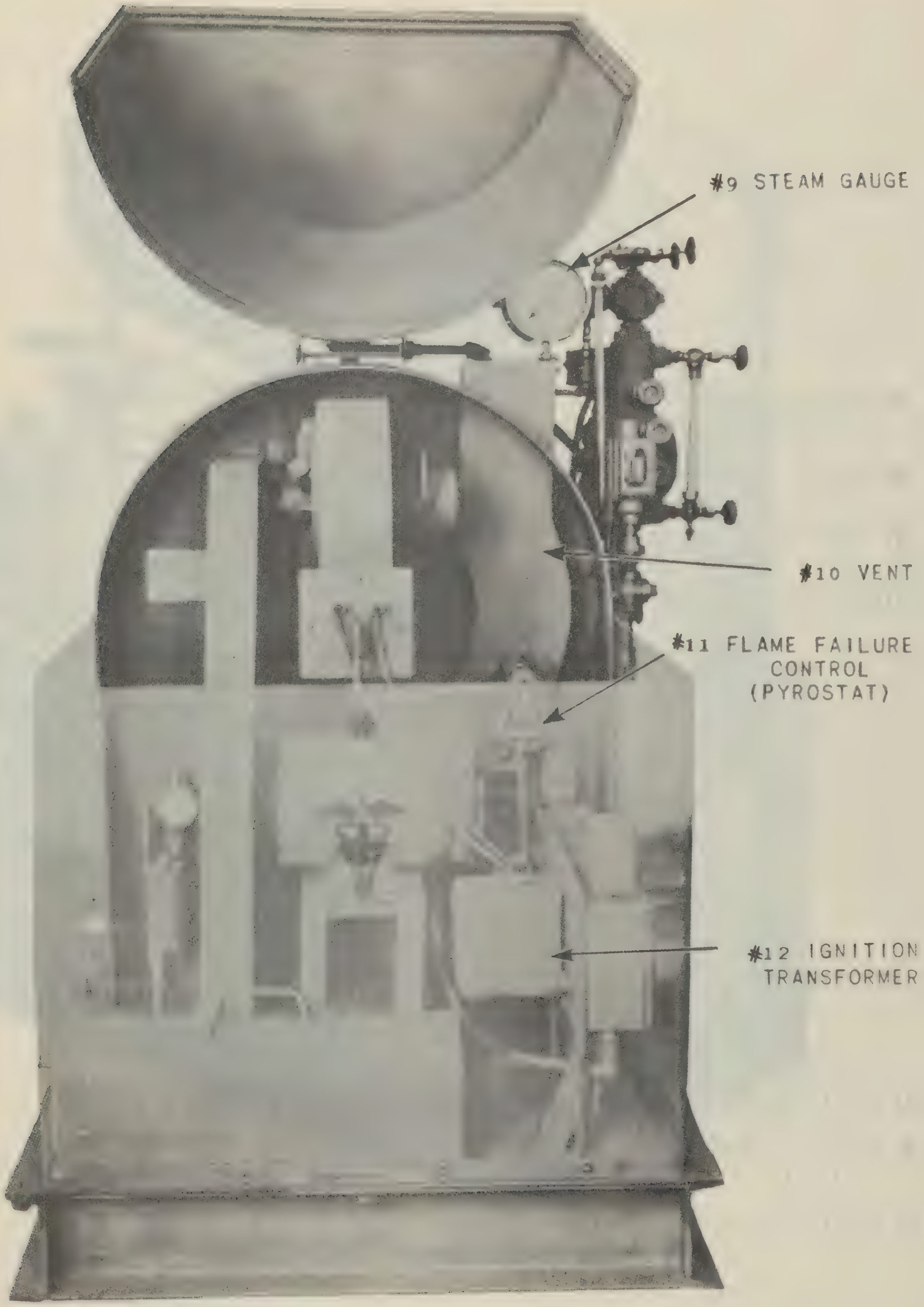

#9 STEAM GAUGE
#10 VENT
#11 FLAME FAILURE CONTROL (PYROSTAT)
#12 IGNITION TRANSFORMER

Figure 2

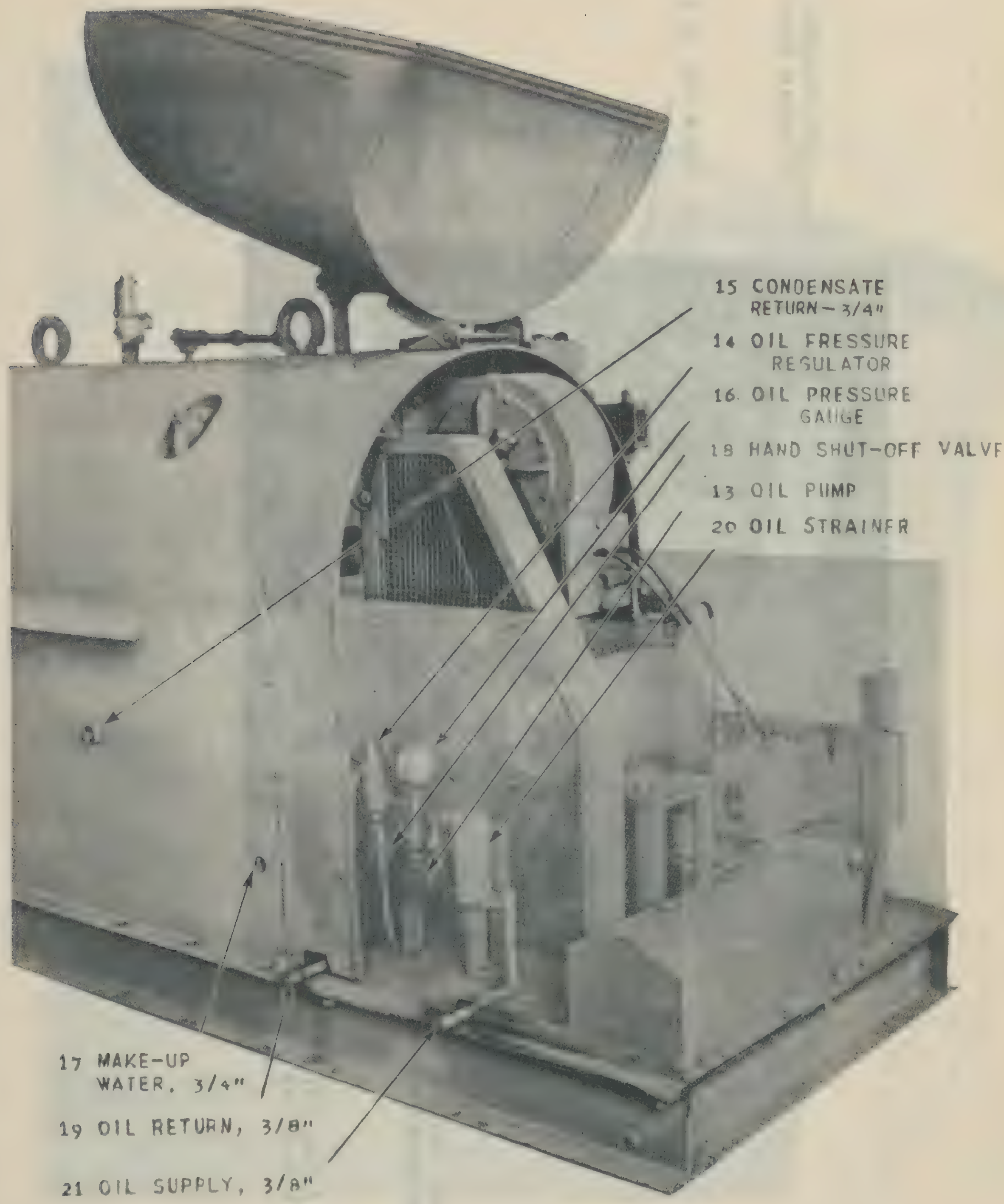

15 CONDENSATE RETURN—3/4"
14 OIL PRESSURE REGULATOR
16 OIL PRESSURE GAUGE
18 HAND SHUT-OFF VALVE
13 OIL PUMP
20 OIL STRAINER
17 MAKE-UP WATER, 3/4"
19 OIL RETURN, 3/8"
21 OIL SUPPLY, 3/8"

Figure 3


#24 O.O. BLOW-OFF VALVE
#25 FEED WATER TEMPERATURE
*22 RECEIVER VENT AND OVERFLOW
#23 CONDENSATE RECEIVER (12 GAL. CAPACITY)

Figure 4


#26 INJECTOR DISCHARGE
TO BOILER
#29 BOILER FEED PUMP
BLOW-OFF "Y" VALVE

Figure 5

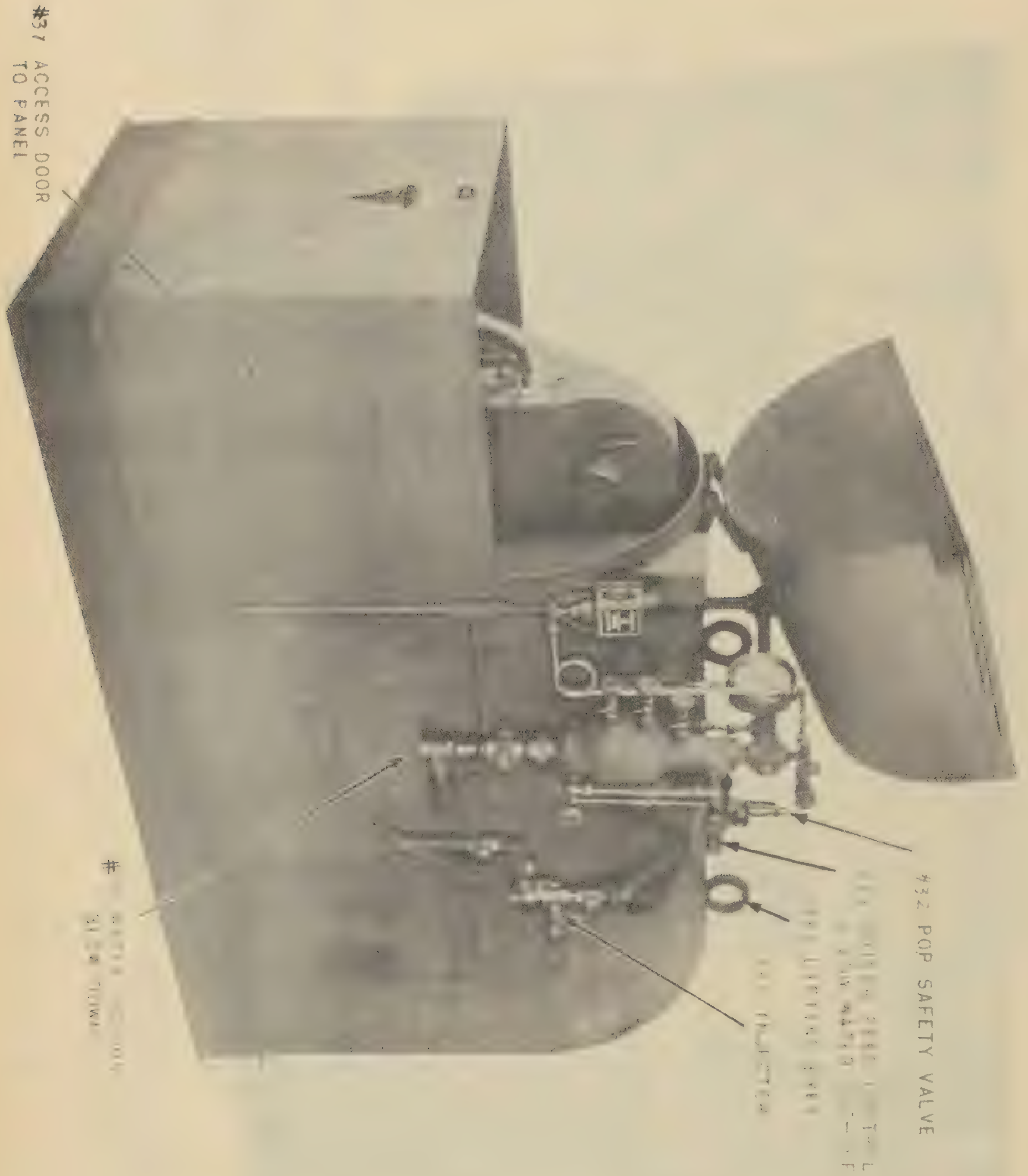
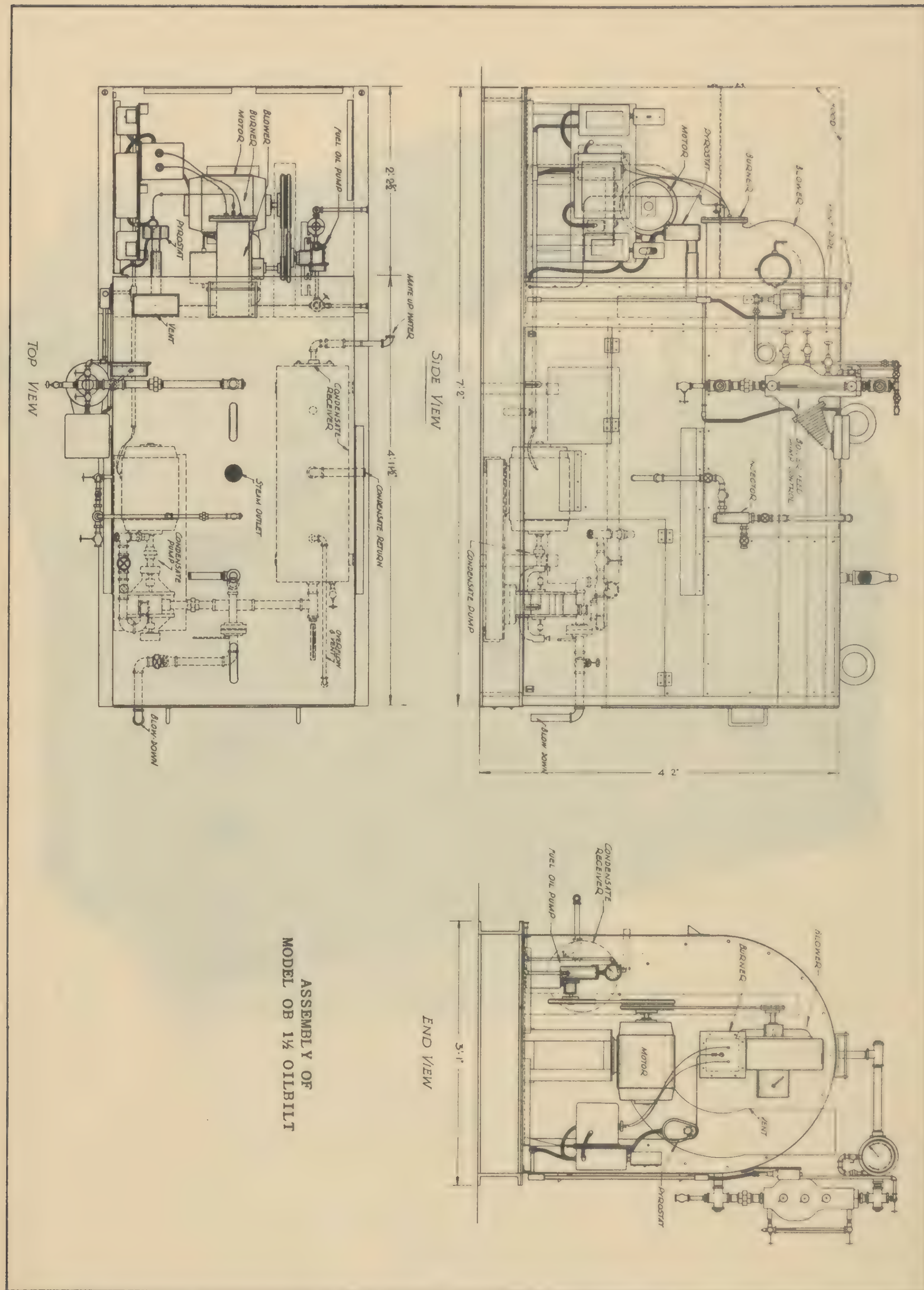


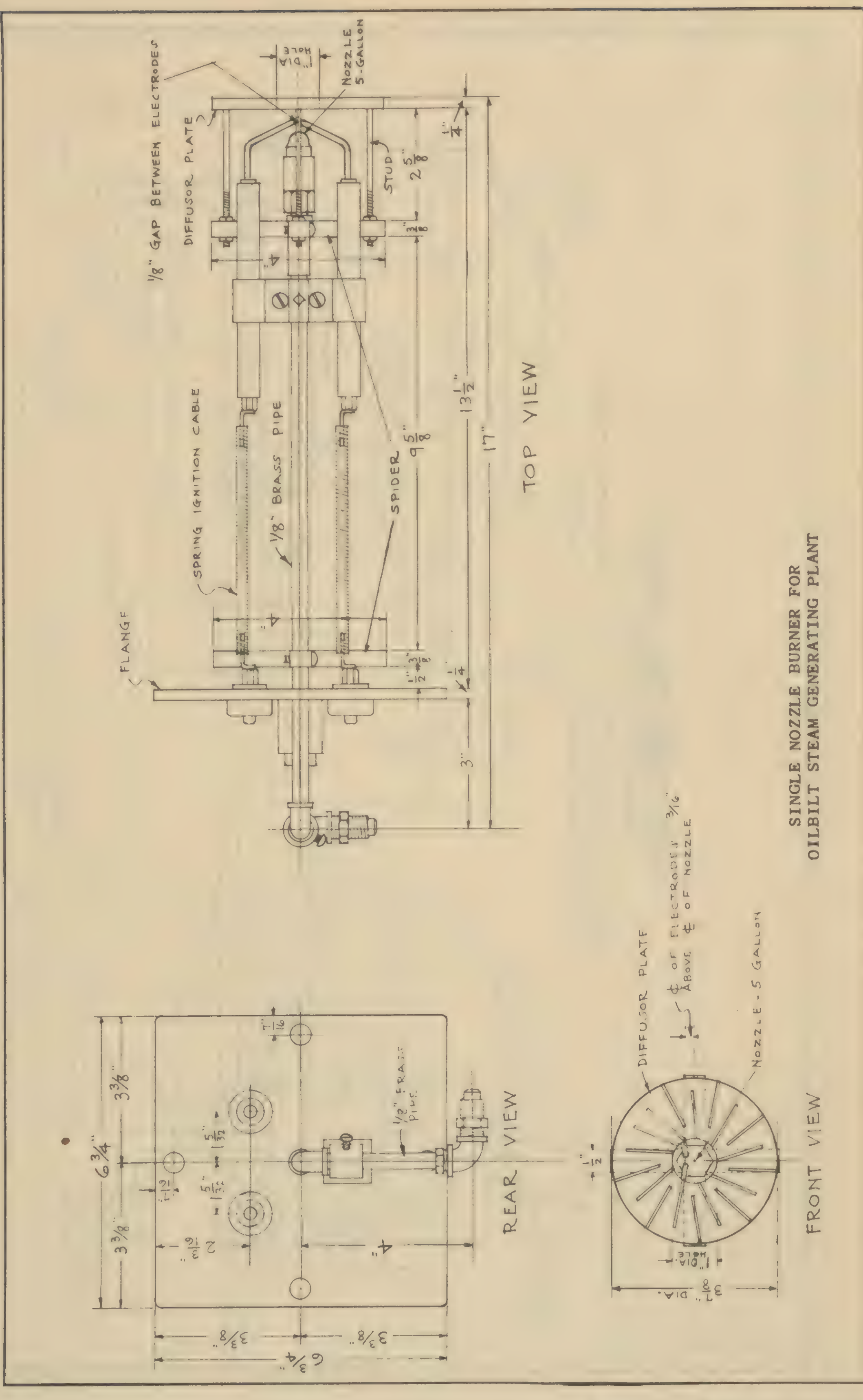
Figure 6

UNIT MAY BE OPERATED
WITH BURNER HOOD CLOSED

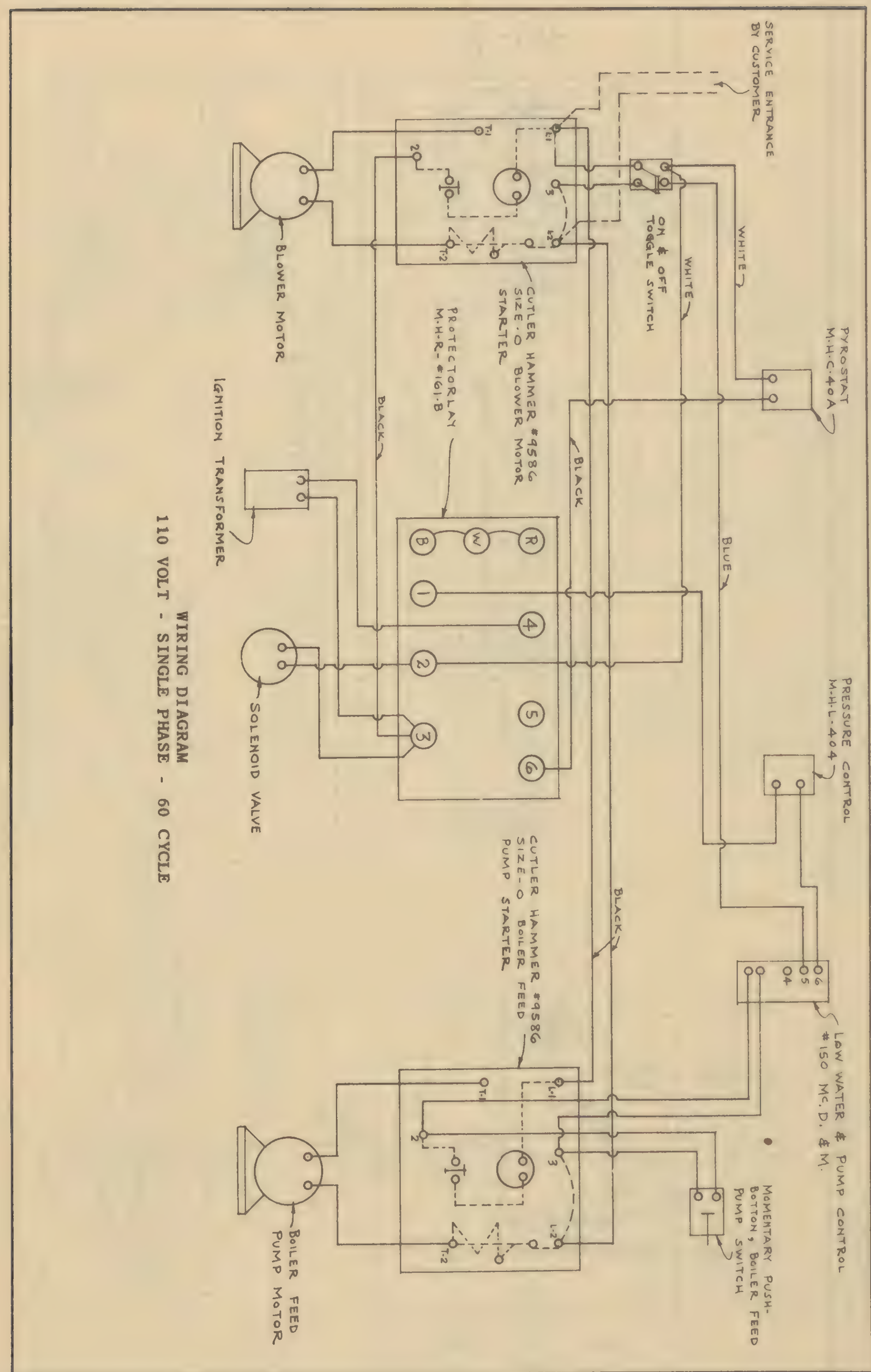
Figure 7



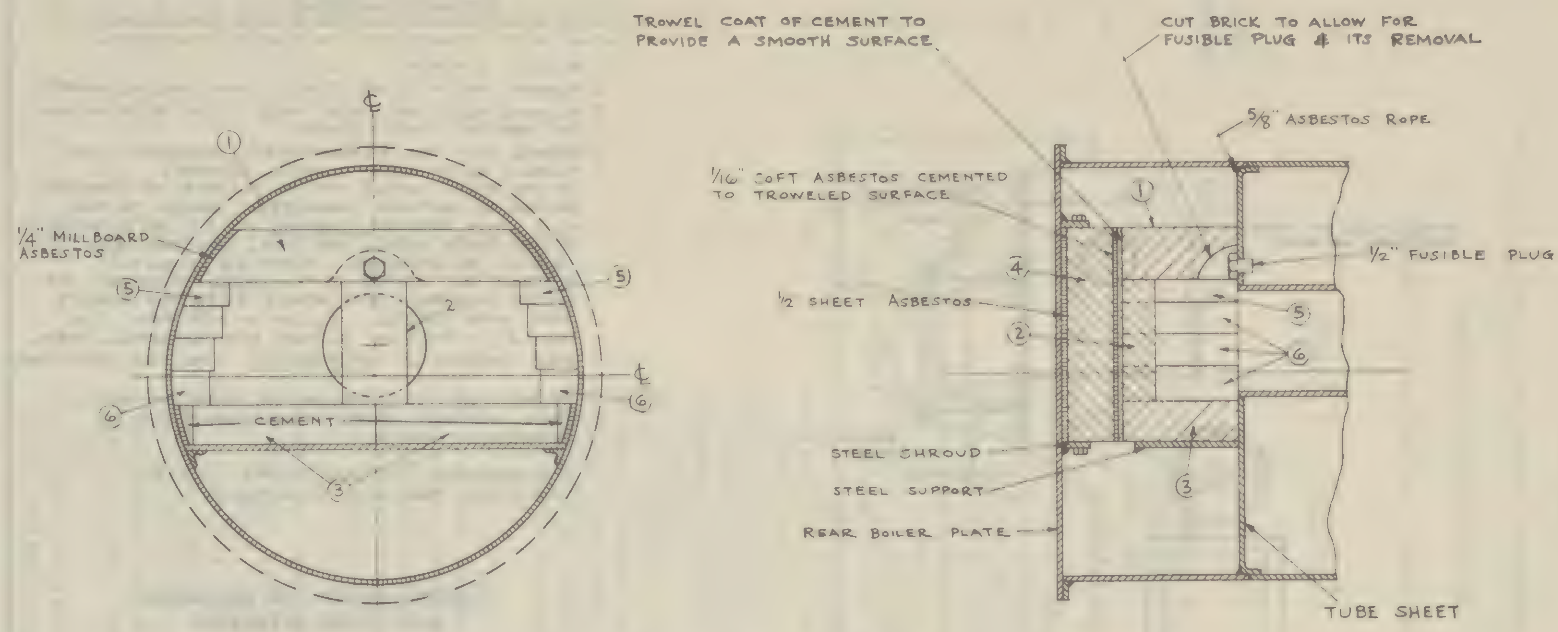
ASSEMBLY OF
MODEL OB 1½ OILBILT



SINGLE NOZZLE BURNER FOR
OILBILT STEAM GENERATING PLANT



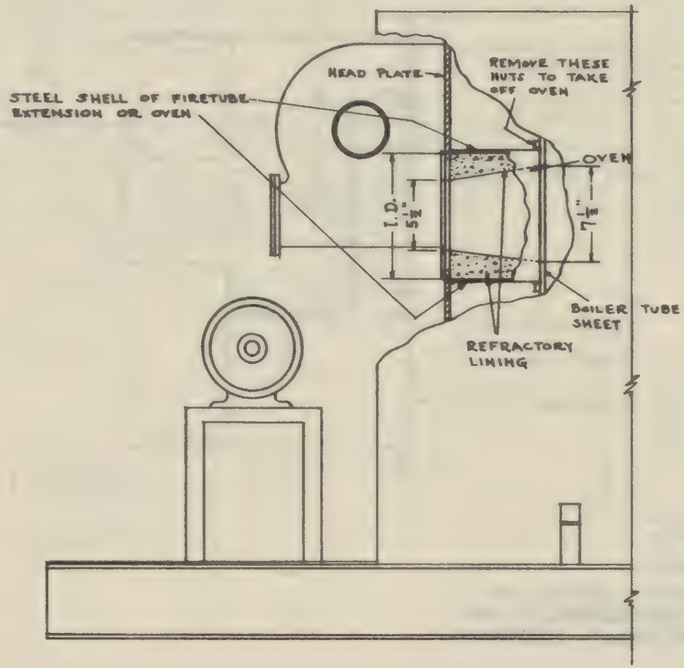
WIRING DIAGRAM
110 VOLT - SINGLE PHASE - 60 CYCLE



25# OF CHICO BRIKSET CEMENT
REQUIRED FOR COMPLETE JOB.

REAR REFRACTORY LINING FOR
OILBILT STEAM GENERATING PLANT
400# STEAM PER HOUR - 100# W.P.

SYMBOL	QUANTITY	MATERIAL
1	1	FIRE TILE - 4" x 9" x 27" CUT TO FIT
2	1	FIRE TILE - 2½" x 4½" x 13½" CUT TO FIT
3	2	FIRE TILE - 3" x 9" x 13" CUT TO FIT
4	1	FIRE TILE - 4" x 14" x 27" CUT TO FIT
5	2	#2 SPLIT BRICK - 2" x 4½ x 9" CUT TO FIT
6	6	FIRE TILE - 2½" x 3½" x 9" CUT TO FIT



INSTRUCTIONS

WHEN USING MEXICO FIREBRICK Co.'S "FURNACECRETE" J-M-CO.'S "FIRECRETE" OR SIMILAR MATERIAL.

1- REMOVE BURNER

2- REMOVE OUTER HEAD PLATE FROM BOILER PROPER

3- REMOVE NUTS HOLDING FIRE TUBE EXTENSION TO BOILER TUBE SHEET

4- KNOCK OUT OLD REFRACTORY MATERIAL AND REPACK WITH NEW PLASTIC CEMENT. TO DO THIS, MAKE UP A SLEEVE OF MANDREL HAVING AN OUTSIDE DIAMETER EQUAL TO THE OLD OVEN OPENING (SHOWN AS I.D. ON DRAWING). STAND OVEN SHELL ON END, AND CENTER THIS SLEEVE IN OPENING. PREPARE PLASTIC CEMENT BY MIXING WITH SMALL AMOUNT OF WATER AND RAM INTO SPACE BETWEEN SLEEVE AND OVEN SHELL. ALLOW TO SET FOR 24 HOURS, WITHDRAW SLEEVE AND REINSTALL OVEN. FIRE GRADUALLY IF POSSIBLE FOR THE FIRST HOUR.

DO NOT PUT TOO MUCH WATER WITH CEMENT, MAKE MIXTURE SAME CONSISTENCY AS MOULDING SAND.

FOR FURTHER INSTRUCTIONS WRITE CLEAVER-BROOKS COMPANY.

INSTRUCTIONS FOR RELINING FIRE TUBE EXTENSION

War Department

St. Louis Medical Department Procurement District

Contract W-2826-MD-1782

Item 99100 Steam Boiler - Model OB 1-1/2

BILL - OF - MATERIALS

C-B Co. Item No.	Quantity Per Boiler	Item
1	2	Square D #8536 Size 0 Starter, Reset only, each with #B15.5 Heater Coils for 110v 60 cy.
2	1	Square D Type B-32 Class 9001 Momentary Switch
3	1	Hubbell #8802 Toggle Switch
4	1	Minneapolis-Honeywell R161B Protector-relay 110v 60 cy.
5	1	Minneapolis-Honeywell C40A Pyrostat
6	1	Minneapolis-Honeywell L404F Pressure-trol, 5-150#
7	2	Marathon 3/4 HP motor, 110v-single phase-60 cycle, 1800 RPM, connection Box R.H. from shaft end
8	1	Webster 511 AJ Ignition Transformer, 110v 60 cy.
9	1	Detroit Lubricator #683-3 Solenoid Valve, 110v 60 cy.
10	1	McDonnell & Miller #150 M Control, head only
11	1	Tuthill OLDK-cc Fuel Oil Pump
12	1	Detroit Lubricator #CRC-481 Strainer
13	1	Monarch G49B Pressure Regulator
14	1	Clarage #15C Blower
15	1	Monarch Oil Atomizing Nozzle, 5 GPH, 60° PLP
16	1	Monarch long brass female nozzle body
17	1	Monarch F80 nozzle strainer
18	2	Isolantite #872-AL5, 5" electrodes
19	46"	GTO-15 Ignition Cable
20	2	Globe Insulator with washer & locknut
21	2	Rajah 0.395 Connectors
22	2	Eismann Brass Eyelets
23	2	Rajah Hook Eyelets
24	6"	Spring Type Ignition Cable
25	2	U.S. 2" Dial Pressure Gauge, 0-200#
26	2	U.S. Type 521 Lever Handle Gauge Cocks
27	1	Straight Syphon
28	1	Aurora D4T Iron Body Bronze Fitted Pump with base & coupling
29	1	Crane, 1", Fig. 2501 Pop Valve set at 100#
30	1	U.S. Type 500 Steam Gauge, 5-1/2" Dial, 0-160# range

War Department
St. Louis Medical Department Procurement District
Contract W-2826-MD-1782
Item 99100 Steam Boiler - Model OB 1-1/2
BILL - OF - MATERIALS (Cont.)

C-B Co. Item No.	Quantity Per Boiler	Item
31	1	Condensate Receiver, 10" x 30", #8 ga.
32	1	Schaub, #35 Make-up Valve
33	2	Roberts, #402 - 1/2" Water Gauge Cocks
34	1	Plain Water Gauge Glass, 5/8" x 5"
35	2	Roberts Gauge Glass Guard Rods, 6-1/2"
36	1	Fisher #260, 1-1/4" Strainer
37	1	Sarco 1/2" - "Y" Strainer
38	1	Everlasting 1" Fig. 1000 B. O. cock
39	1	Lunkenheimer 1" Fig. 180 - "Y" Valve
40	1	" 1/8" Fig. 740 Vertical Ball Check Valve
41	2	Lunkenheimer 1/4" Fig. 407 Globe Valve
42	1	" 3/8" Fig. 739 Angle Ball Check Valve
43	1	Lunkenheimer 1" Fig. 73 Globe Valve
44	1	" 1" Fig. 554 Check Valve
45	2	Drain Cocks, 1/8" Brass Air Cocks
46	1	Tuthill Pump Discharge Flange
47	2	Flange Gaskets, Detroit Lubricator CRC 481 Strainer
48	1	Moeller 4" Flat Back Hot Water Thermometer (50-400^{o} F.)
49	2	#1 Handhole Ring
50	1	Burner Diffuser Plate
51	1	Burner Brass Spider
52	1	Burner Electrode Holder
53	1	Burner End Plate
54	1	Burner End Plate Gasket
55	1	Pyrostat Adaptor Pipe
56	1	Motor Heat Shield, 13-1/2" x 15"
57	1	Boiler Shell Insulation
58	1	Boiler Shell Lagging
59	1	Pressuretrol Guard Box
60	1	Boiler Feed Pump Motor, Protecting Sheet
61	1	C-B Co. #315A Water Column
62	1	Motor Sheave, 6.0A, 3/4" Bore, 3/16" x 3/32" Keyseat, 2 groove
63	1	Blower Sheave, 3.2A, 15/16" Bore, 1/4" x 1/8" Keyseat, Single Groove
64	1	Oil Pump Sheave, 6.0A, 7/16" Bore, no Keyseat, Single Groove
65	1	Blower Belt, A54
66	1	Oil Pump Belt, A42
67	1	Oilbilt Nameplate, 3-1/2 x 5"

War Department
St. Louis Medical Department Procurement District
Contract W-2826-MD-1782
Item 99100 Steam Boiler - Model OB 1-1/2
BILL - OF - MATERIALS

Spare Parts

C-B Co. Item No.	Quantity Per Boiler	Item
15	2	Monarch Oil Atomizing Nozzles, 5 GPH, 60° PLP
17	2	Monarch Nozzle F80 Strainers
18	2	Isolantite #872-AL5, 5" Electrodes
19	46"	GTO-15 Ignition Cable
24	6"	Spring Type Ignition Cable
9	1	Detroit Lubricator #683-3 Solenoid Valve, 110v 60 cy.
20	2	Globe Insulators
21	2	Rajah 0.395 Connectors
23	2	Rajah Hook Eyelets
22	2	Eismann Brass Eyelets
11	1	Tuthill OLDK - cc Fuel Oil Pump
	1	Detroit Lubricator #CRC481 Strainer Screen only
	2	Square D #B15-5 Heater Coils
	12	Handhole Gaskets, 2-3/4" x 3-1/2"
	12	Handhole Bolt Gaskets
62	2	Pyrex Red Line Water Column Gauge Glass, 5/8" x 10-1/4"
	2	Gauge Glass Gaskets
25	2	U.S. 2" Dial Pressure Gauge, 0-200#
	1	Minneapolis-Honeywell C40A Pyrostat Element only
8	1	Webster 511AJ Ignition Transformer, 110v 60 cy.
	1	McDonnell & Miller #150 Sylphon Assembly
	1	McDonnell & Miller #150 3-wire tube
	1	" " #150 2-wire tube
	1	Tool Box, #21-1 Hamilton
	1	Bit Snap, #421

Electrical Fittings

	1	Handy Box, #4SSL
	1	Handy Box Cover, #2594
	35	Sta-Kon Lugs, #B-36
	3	1/2" T Unilets
	1	1/2" No Thread T Unilet
	1	1/2" LB Unilet
	5	1/2" Unilet Cover
	3	1/2" One-Ear Pipe Clamp
	2	1/2" x Close Galvanized Conduit Nipple
	1	1/2" x 2" Galvanized Conduit Nipple
	2	1/2" x 3" Galvanized Conduit Nipple (Thread one end)

War Department
St. Louis Medical Department Procurement District
Contract W-2826-MD-1782
Item 99100 Steam Boiler - Model OB 1-1/2
BILL - OF - MATERIALS

Electrical Fittings (Cont.)

C-B Co. Item No.	Quantity Per Boiler	Item
	1	1/2" x 3-1/2" Galvanized Conduit Nipple
	1	1/2" x 4-1/2" Galvanized Conduit Nipple
	3	1/2" Galvanized Conduit Coupling
	3	1/2" Galvanized Straight Squeeze Connectors
	1	1/2" Galvanized 90° Squeeze Connectors
	4	1/2" Galvanized Conduit Locknuts
	16	1/2" Galvanized Conduit Bushings
	9"	1/2" Greenfield
	48-1/2"	1/2" Galvanized Conduit
	6	3/8" Galvanized Straight Squeeze Connectors
	3	3/8" Galvanized 45° Squeeze Connectors
	7	3/8" Galvanized 90° Squeeze Connectors
	75"	3/8" Extra Flex
	43"	3/8" Greenfield
		Wire
	24'- 0"	#14 Blue Flamenol Wire
	20'- 0"	#14 Black " "
	6'- 6"	#14 White " "
	9'- 6"	#14 Yellow " "
		Brass & Copper Parts
	1	1" x 4-1/2" Extra Heavy Brass Nipple
	60"	3/8" O.D. Bundy Steel Tubing
	4	3/8" O.D. x 1/4" IPS Grinnell Adaptor
		Machine Parts
	12	1/4-20 x 3/8" Hex. Head Cap Screws
	7	1/4-20 x 1/2" " " " "
	4	1/4-20 x 3/4" " " " "
	8	1/4-20 x 1" " " " "
	4	1/4-20 x 1-¼" " " " "
	4	1/4-20 x 1-½" " " " "
	3	1/4-20 x 5/8" Machine Screws
	2	1/4-20 x 3/4" " "
	4	1/4-20 Hex. Nuts
	12	1/4" Flat Washers
	12	1/4" Lock Washers
	11	10-32 x 3/8" Machine Screws
	8	10-32 x 5/8" " "
	8	10-32 Brass Nuts
	4	10-32 x 3-3/4" Studs, Thread 2" One End, 1/4" Other End
	4	5/16"-18 x 3/4" Hex. Head Cap Screws
	4	5/16" Flat Washers

War Department
St. Louis Medical Department Procurement District
Contract W-2826-MD-1782
Item 99100 Steam Boiler - Model OB 1-1/2
BILL - OF - MATERIALS

Machine Parts (Cont.)

C-B Co. Item No.	Quantity Per Boiler	Item
	4	5/16" Lock Washers
	4	3/8"-16 x 3/4" Hex. Head Cap Screws
	4	5/8"-11 Hex. Steel Nuts
	2	#4 x 1-1/2" Taper Pins
	16"	1/4" x 1" Bar Iron
	5'- 2"	1/4" x 1-1/2" Bar Iron
	1	9" x 23" x 3/16" Panel
	1	4" x 4" x 3/16" Panel
	1	1-1/4" x 12" x 3/16" Panel Leg
		Pipe & Fittings
	1	1/8" Black Malleable Ell
	1	1/8" x 2-1/2" Black Nipple
	1	1/8" x 3" Black Nipple
	15"	1/8" Black Pipe
	6	1/4" x Close Black Nipple
	1	1/4" x 1-1/2" Black Nipple
	3	1/4" x 2" Black Nipple
	1	1/4" x 2-1/2" Black Nipple
	2	1/4" Plug
	2	1/4" Black Ground Joint Union
	2	1/4" Black Malleable T
	4	1/4" Black Malleable Ell
	1	1/4" x 1/8" Black Malleable Reducing Coupling
	1	1/4" Black Malleable Street Ell
	2	3/8" Black Malleable Coupling
	1	3/8" Black Malleable Street Ell
	1	3/8" x 1/4" Black Bushing
	1	3/8" x Close Black Nipple
	1	3/8" x 3-1/2" Black Nipple
	1	3/8" x 5-1/2" Black Nipple
	1	1/2" Plug
	1	1/2" Black Malleable Ell
	1	1/2" Black Malleable Street Ell
	2	1/2" Black Ground Joint Union, XH
	1	1/2" Black Malleable Ell, XH
	1	1/2" Black Malleable Street Ell, XH
	3	1/2" Black Malleable 45° Ell, XH
	1	1/2" x 3/4" Black Reducing Coupling
	1	1/2" x Close Black Nipple
	2	1/2" x Short Black Nipple
	2	1/2" x 3-1/2" " "
	2	1/2" x 4" " "
	1	1/2" x 4-1/2" " "
	5'- 0"	1/2" Black Pipe
	2	3/4" Plug
	1	3/4" Black Malleable T, XH
	1	3/4" x 1/2" Black Bushing
	1	3/4" x 2-1/2" Black Nipple

War Department
St. Louis Medical Department Procurement District
Contract W-2826-MD-1782
Item 99100 Steam Boiler - Model OB 1-1/2
BILL - OF - MATERIALS

Pipe & Fittings (Cont.)

C-B Co. Item No.	Quantity Per Boiler	Item
	1"	3/4" Black Double XH Pipe
	2	1" Plug
	2	1" Black Coupling
	1	1" x 1/2" Black Bushing
	1	1" Black Ground Joint Union, XH
	1	1" x 3/4" Black Malleable Reducing Coupling
	4	1" Black Malleable Ell
	1	1" Black Malleable Ell, XH
	2	1" " " T, XH
	1	1" " " Street Ell
	1	1" Forged Steel Ell
	4	1" x Close Black Nipple
	1	1" x Short " "
	4	1" x 2-1/2" " "
	1	1" x 2-1/2" " " , XH
	1	1" x 3" " "
	3	1" x 4" " "
	1	1" x 5" Black Nipple (Thread One End)
	2	1" x 6" " " , XH
	1'- 0"	1" Black Pipe
	1	1-1/4" Black Ground Joint Union
	1	1-1/4" x 1/2" Black Bushing
	1	1-1/4" Black Malleable T
	2	1-1/4" x Close Black Nipple
	1	1-1/4" x 2" Black Nipple
	1	1-1/4" x 3" " "
	1	1-1/4" x 6" " "
	1	2" x 3/4" Black Bushing
	1	2" Black Malleable Coupling
	1	2" x 3" Black Nipple

Auxiliary Oil Piping & Fittings

	20	10'-0" Length 3/4" Black Pipe Threaded & Coupled
	25	3/4" Black Ground Joint Union
	10	3/4" Black Malleable Ell
	2	3/4" Lunkenheimer Fig. 2125 Gate Valve
	12'-6"	3/8" O.D. Type K Annealed Copper Tubing
	2	3/8" IPS x 3/8" C #404 Adaptors

EXPLANATION OF WIRING DIAGRAM - Power supply of 110 volts must be connected to terminals L_1 and L_2 of burner motor starting relay.

The water pump motor and its starting relay are also connected to L_1 and L_2, they are not indicated on this drawing.

The following letters and numbers on the drawing indicate marked terminals on the "Protectorelay": R, W, B, 1, 2, 3, 4, 5.

The Roman numerals indicate the 3 relay coils of the "Protectorelay", coil I being on the left side, coil III on the right.

The low water cutout is referred to as LWCO. The letters L, C and R stand for "left", "center", and "right", indicating the position of the contacts on each of the 3 relays on the "Protectorelay".

All contacts on the "Protectorelay" are shown in their *"normal" position, that is the position they assume when the power supply is shut off.* On each of the 3 relays the lower contacts are normally open, the upper contacts normally closed. In the following explanation they are referred to as NO and NC. For example, III RNC is the normally closed, therefore, upper contact on the right side of relay III.

Steps of operation of Protectorelay:

1. When toggle switch, pressure switch and low water cutout (terminals 5,6) are closed the primary of the step down transformer is energized.

2. Step down transformer secondary and *relay coil I* is closed through warp switch heater, III RNC, B, W and warp switch contacts.

3. When relay I contacts close: *Ignition* is energized through (2), (4), II-LNC, I-R, (1).

Blower motor relay coil is energized through C_1 (3), II-RNC, I-R, (1).
Solenoid Valve is energized through (2), (3), II-RNC, I-R (1).

4. When *Pyrostat* closes, relay coil III is energized.

III RNC opens, but *relay coil I* is kept energized through III-RNC, by-passing heater of warp switch.

Relay Coil II is closed through (2), III-C, I-R, (1).

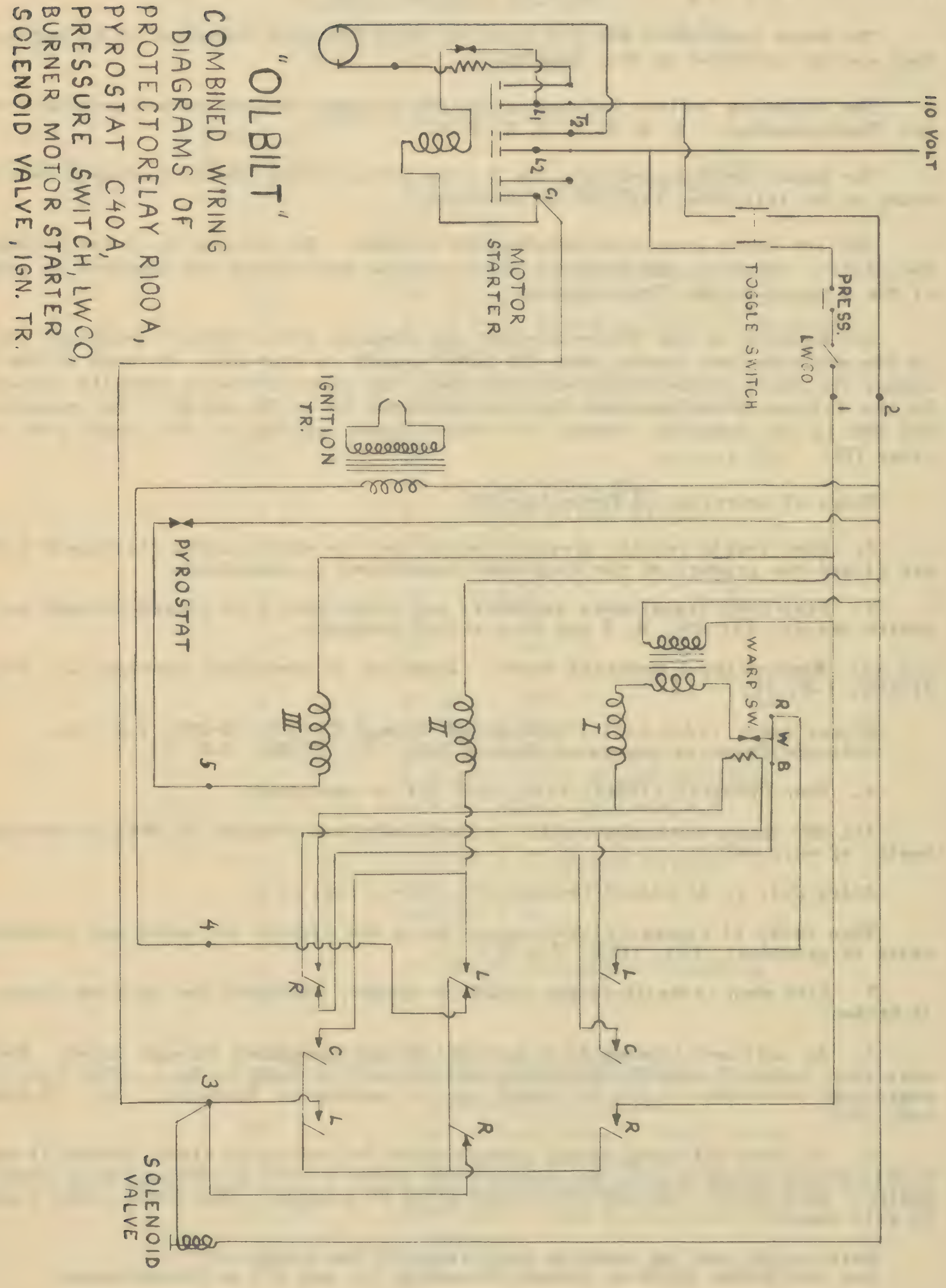
When relay II closes, II-RNC opens, but a new circuit for motor and solenoid valve is provided: (3), III-L, I-R (1).

5. Also when relay II closes II-LNC is opened, therefore the ignition circuit is broken.

6. As outlined in step 4, relay coil II was energized through III-C. However when relay II closes, an additional circuit is made to keep relay coil II energized, even when relay III opens due to opening of Pyrostat: (2), II-LNO, I-R, (1).

7. If relay III opens during operation due to cooling of stack, relays II and I will still be energized, but current for relay I will go through warp switch heater. Warp switch contacts will break after 90 seconds. Then both, relay I and II will open.

Warp switch must be reset by hand after it has cooled off.
For continuous ignition connect terminals (3) and (4) on Protectorelay.



"OILBILT"
COMBINED WIRING
DIAGRAMS OF
PROTECTORELAY R100A,
PYROSTAT C40A,
PRESSURE SWITCH, LWCO,
BURNER MOTOR STARTER
SOLENOID VALVE, IGN. TR.

CHAPTER X

STEAM GENERATORS

SECTION 3

TREATMENT AND CONTROL OF FEED WATER

FIELD INSTRUCTIONS FOR TREATMENT AND CONTROL OF FEED WATER FOR ARMY FIELD STEAM GENERATORS #99100

It is obviously impossible for anyone to prescribe an exact feed water control unless the following information is available.

1. Amount of raw water feed to boiler.
2. Amount of condensate returned to boiler.
3. Complete chemical analysis of raw water.
4. Periodic chemical analysis of boiler water (from boiler)

Then too, the most accurate control depends upon strict adherence by the operator to the dosage of certain recommended chemicals. Substitutions of other chemicals changes the entire result. While it is to be emphasized that if the above conditions are not known, it is impossible to prescribe specific treatment for any given situation, it is quite imperative that approximate rules be taught the operator so that he can stay within reasonable limits of good treatment practice. The outline submitted below is intended and can do no more than give the broad rules to follow. The rest is up to the operator. As indicated above, the treatment of boiler feed water under normal conditions is based on a thorough knowledge of local conditions and the advice of a competent water chemist, with a periodic check-up to see that correct treatment is maintained.

It must be thoroughly understood that the suggestions to be made on the following pages are purely and simply makeshift and would under normal conditions be considered extremely crude, however, the boilers which we are discussing may be shipped to various and remote parts of the world where conditions would probably be such that no personnel or facilities would be available to analyze or treat the feed water on a proper scientific basis. When a boiler is shipped it cannot be predicted under what circumstances the boiler will be used, neither can it be determined in advance what percentage of raw feed water will be used, nor for the matter, can it be foreseen whether the condensate will be returned to the condensate receiver at all. For our purpose it will be assumed that in most cases there may be no return of the condensate to the boiler.

In order that the operator may thoroughly understand the basis upon which these suggestions are to be made, we may cite the following analogy. Most of us are familiar with the infinite possibilities of baling wire as a means of effecting temporary repairs on harness or other equipment around a farm. No harness maker or manufacturer of agricultural equipment would consider the use of baling wire as a recommended procedure in effecting the repair of such items. However, the farmer, miles away from a source of supply and in the middle of a chore has to improvise his repairs which is exactly what we have to do in the case of treating boiler feed water. Certainly no water chemist would consider the treatments to be suggested as the best to be desired, but they will at least tend in an emergency to overcome too rapid scaling and consequent loss of efficiency and even ultimate uselessness of the boiler due to excessive scale of formation which is readily caused by untreated water.

As mentioned above, because of the fact that boilers must operate under a variety of field conditions, it is not possible to outline an exact method of feed water treatment nor is it possible to obtain in the field the usual commercial chemicals employed for feed water treatment. On the other hand it is of the utmost importance that the boiler operator be sufficiently familiar with the problem of feed water treatment so that he can, by certain simple means, institute some form of treatment depending on the type of feed water encountered and the quantity of make-up water employed on the given boiler. A knowledge of these things will avoid serious scaling and corrosion, if not damage to the boiler. Failure to follow certain basic operating rules will shorten the life and may cause serious damage to vitally needed military field equipment.

The basis of all feed water treatment is a knowledge of how much raw water is fed to the boiler and what minerals such raw water contains. Since it may not be practical to provide complete means of analyzing raw feed water, it is necessary to use several materials and arbitrary forms of treatment, basing the quantity of such treatment solely on the amount of raw water used.

The suggested treatment below is, for the sake of safety, based on the assumption that boilers will be operated with 100% raw make-up. After employing the dosage as recommended, there may be either one of two results; overtreatment or undertreatment. Overtreatment of water, while preventing scale formation may result in foaming or priming of the boiler. This will be evidenced by a rapidly fluctuating water line in the gauge glass, if not by actual carry-over of water into the steam line. The other result (undertreatment, the dosage outlined being insufficient) will be the formation of a certain amount of scale. The degree of undertreatment can only be determined by running the boiler with the prescribed dosage for a period of two to four weeks. The hand holes of the boiler should then be opened and inspection made of the tube and shell surfaces. If no early formation of scale is detected and no foaming or priming has been evidenced, it may be assumed that the treatment followed is approximately correct for the water conditions and other conditions of operation in effect.

The formation of scale should, however, be watched at succeeding thirty day intervals until it is firmly established that no undue amount of scale is forming. A thin scale formation, even as high as 1/16" thick is not dangerous providing that it does not increase in thickness beyond this point over a period of months during which interval examinations of the boiler have been made.

A good operator will not permit a boiler to approach the maximum limits of scale formation but will rather try to prevent scale so that there is only a thin film. The greater the amount of scaling the less efficiently the boiler operates.

Whenever a boiler is operated with a high percentage of raw make-up, it must be remembered that this water is introducing additional mineral matter to the boiler and it is of the utmost importance that a regular blow-down schedule be employed so that sediment as well as dissolved solids in the boiler water are continually removed from the boiler by dilution. Feed water treatment by means of chemicals will tend to change the minerals to a sediment of non-scaling form. If blow-down is not employed, this soft sediment can become a hard material which will ultimately coat the boiler surface and result in as much harm as if no treatment had been employed.

When employing 100% make-up, it is desirable to blow-down the boiler not less than once every eight hours of continuous operation. The blow-down should be carried out by first loading the boiler above its normal water level and then blowing down to the normal level. This permits the blow-down to be done without shutting down the boiler or equipment depending on a constant steam supply. Overloading of the boiler is done by using the momentary push button switch on the boiler feed pump or by using the injector. Overloading should be not more than two or three inches over the normal water level.

Among the chemicals most suited for basic water treatment are the following:

1. Sodium Carbonate or Soda Ash
2. Caustic Soda
3. Caustic Potash or Lye
4. Tri Sodium Phosphate
5. Vegetable Materials such as Tannates

There are many commercial materials sold under various trade names and usually composed of one or more of the above chemicals. The use of such compounds may follow the dosage given below if no directions are provided.

The first four materials listed are crystalline and should be dissolved in water before admission to the condensate receiver from which the pump will feed the solution into the boiler. For convenience a permanent pipe and funnel arrangement may be attached to the top of the receiver for feeding the chemical solution into the receiver. The basic dosage for the above material should be one quarter pound for every one thousand gallons of raw make-up. This is equivalent to thirty hours of operation of the boiler at 50% load. Correction of this dosage can only be made after observation as previously outlined.

Never add crystalline or undissolved material to receiver because it will carry through the small clearances of the pump before it dissolves, causing abrasion and thus ruining the pump. Always dissolve chemicals in water and then pour directly into condensate receiver.

It is not easy to prescribe a dosage for the vegetable materials, yet they may constitute one of the most readily available materials in the field. Among these materials are infusions made from the bark of trees which contain high amounts of tannic acid. The cooking water used in boiling raw potatoes may be used without further dilution. Tea leaves, while a good vegetable treatment must not be employed by placing such materials in the receiver since they will clog up the pump and strainer. Tea leaves may be added through hand holes. The potato peelings may be added to the boiler by means of one of the upper hand hole plates. No more than a quart of peelings should be employed per week until the operator becomes familiar with the action of the peelings and the effect on priming. In localities where it is possible to obtain the total supply of make-up water from swamps or woodland streams, such waters if free from silt, oil or other solid material provide an excellent source of dissolved vegetable material including tannates. Such stream waters usually contain little or no mineral matter and have only a small concentration of vegetable material useful for treatment, therefore to obtain the full benefit from such water, it must be employed as total feed to the boiler rather than the addition of small quantities as would be done when using the dissolved crystalline materials outlined above.

While there are a number of washing compounds which may be available, such compounds must never be used for feed water treatment if they contain any soapy material. This can easily be determined by seeing whether suds are formed when such washing compounds are added to water. Soapy materials will cause severe priming and foaming. Never add lime or alum to boiler feed water. These materials are employed only for the treatment of raw water externally and before water so treated is admitted to the boiler.

All boilers should receive a periodic washing. The frequency will depend on the amount and character of the raw water and of the treatment employed. Even though internal treatment follows good practice, it is never possible to remove silt or precipitate from all portions of the boiler shell. To wash out a boiler, the steam pressure must first be relieved and the boiler cooled, preferably for a period of five to ten hours. Then after emptying the boiler, it can be opened and all surfaces washed down with a hose. It is suggested that washing down be done at the time that the boiler is opened for internal inspection of scale. This would mean washing down would be done every thirty days unless a longer or shorter period was indicated by the condition of the boiler found after one or two inspection periods.

SUPPLEMENTARY INSTRUCTIONS FOR SCALE REMOVAL IN ARMY FIELD STEAM GENERATORS

In the event that no feed water treatment has been employed and the operation of the boiler otherwise neglected so that heavy scale formation has taken place, the operator will ask the question as to what can be done to remove the scale. The answer to this question is that heavy scale deposits can *not be* removed by any simple means. This should emphasize the need for continuous treatment throughout the life of a boiler.

The practical difficulties which make the removal of scale difficult if not impossible are as follows:

1. Internal feed water treatment may be carried out with more than the normal dosage of chemicals but this will effect some resolution of the scale only over a long period of time.

2. On a small boiler there is no internal space nor can there be provided a sufficiently large access opening to expose all internal portions of the boiler. The only way, therefore, to try to loosen scale by mechanical means is to use a tube rattler. While this may loosen some scale on the tubes it can not effect the scale on the shell. Moreover, the removal of any loose scale must still be accomplished. Should scale become loosened by either chemical or mechanical means, it may drop off the tubes in large segments. These segments will become lodged in the tube band and unless poked through will cause serious damage when the boiler is again fired. Such scale accumulations on the heating surface prevents conduction of heat into the water and results in local overheating of the steel at that point. When the steel becomes red hot the boiler pressure will bag or rupture the tubes at such points.

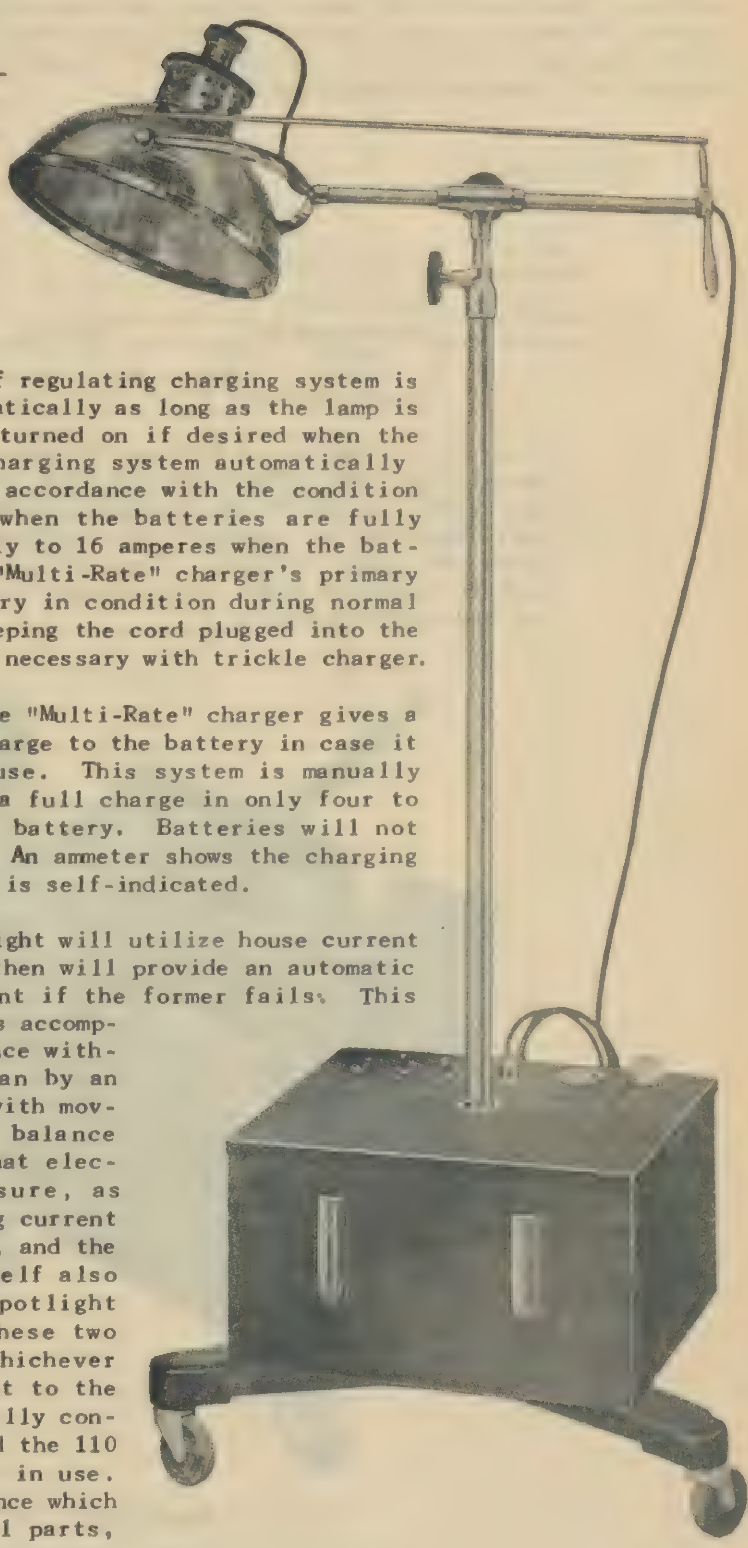
3. The removal of scale by means of acid is attended by many difficulties and is dangerous to the boiler itself. Scale which contains large amounts of sulphate is not attacked by acids.

CHAPTER XI

EMERGENCY OPERATING SPOTLIGHTS

WILMOT CASTLE

These lights use an 80 watt, 12 volt double filament safety bulb. One filament of the bulb will burn out approximately eight hours before the other, thus warning the staff that a new bulb should be installed.



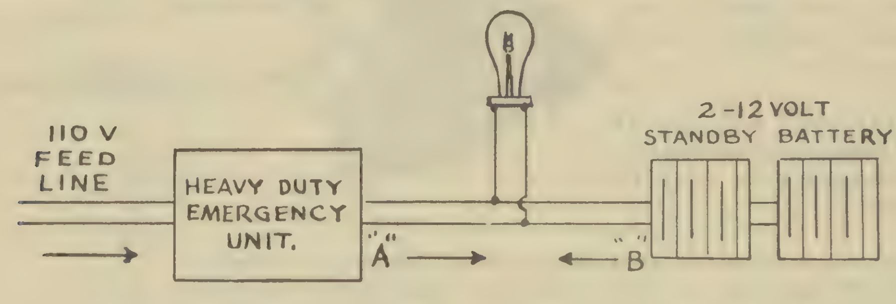
Castle uses two 6 volt stand-by type batteries in a series connection to give 12 volt current.

A dual high capacity self regulating charging system is provided which operates automatically as long as the lamp is in use, and can be manually turned on if desired when the lamp is not in use. This charging system automatically adjusts its charging rate in accordance with the condition of the battery: From zero when the batteries are fully charged, stepping up gradually to 16 amperes when the batteries are discharged. The "Multi-Rate" charger's primary purpose is to keep the battery in condition during normal use. It does this without keeping the cord plugged into the wall 24 hours a day, which is necessary with trickle charger.

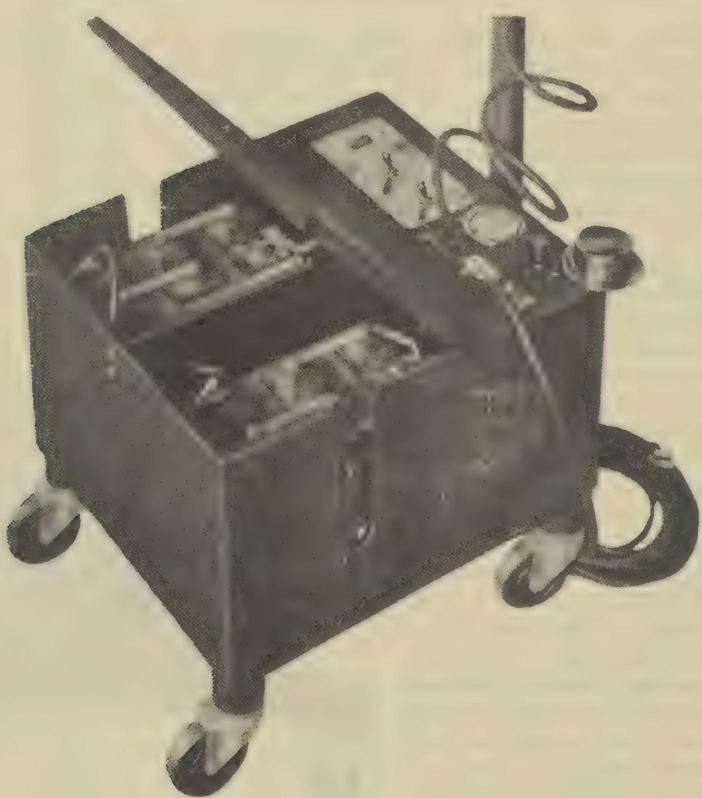
As a second function, the "Multi-Rate" charger gives a quick, full and controlled charge to the battery in case it is discharged by emergency use. This system is manually controlled and will restore a full charge in only four to six hours without removal of battery. Batteries will not discharge through rectifier. An ammeter shows the charging rate. Condition of batteries is self-indicated.

Of course an emergency light will utilize house current under normal conditions and then will provide an automatic change-over to battery current if the former fails. This change-over in Castle units is accomplished by an electrical balance without moving parts, rather than by an automatic mechanical switch with moving parts. This electrical balance makes use of the principle that electricity has force or pressure, as measured by voltage. Incoming current as rectified, has one voltage, and the current from the battery itself also has its own voltage. The spotlight bulb is connected between these two voltages or pressures, and whichever is the stronger feeds current to the bulb. The lamp bulb is normally connected to both the battery and the 110 volt supply when the lamp is in use. Thru means of electrical balance which involves no moving mechanical parts,

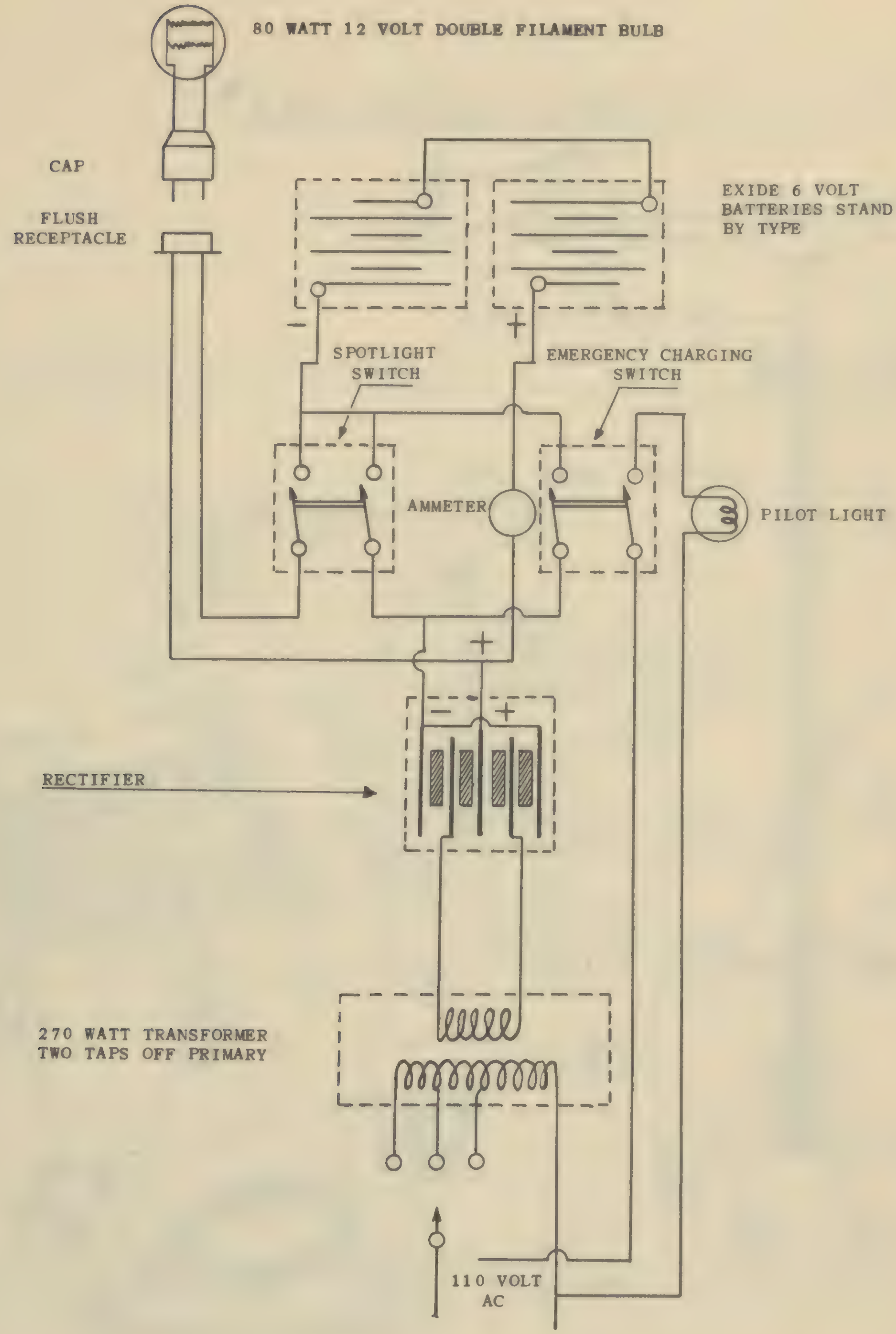
the lamp bulb will draw its current supply so long as that supply maintains full voltage. But should the house current voltage dim down, the electrical balance permits the bulb to draw from the battery the additional current necessary to make up the shortage and hence to maintain full brightness at all times. There is no dimming or flickering of the lamp bulb.



Diagramatic sketch of Voltage Balance without moving parts. 110 volt current is rectified by charging unit. It exerts a force "A" to light the bulb and simultaneously sustains the charge in the battery. If electrical force "A" ceases, or dims, force "B" from battery pushes back to light the bulb. This change-over is instantaneous and non-mechanical.

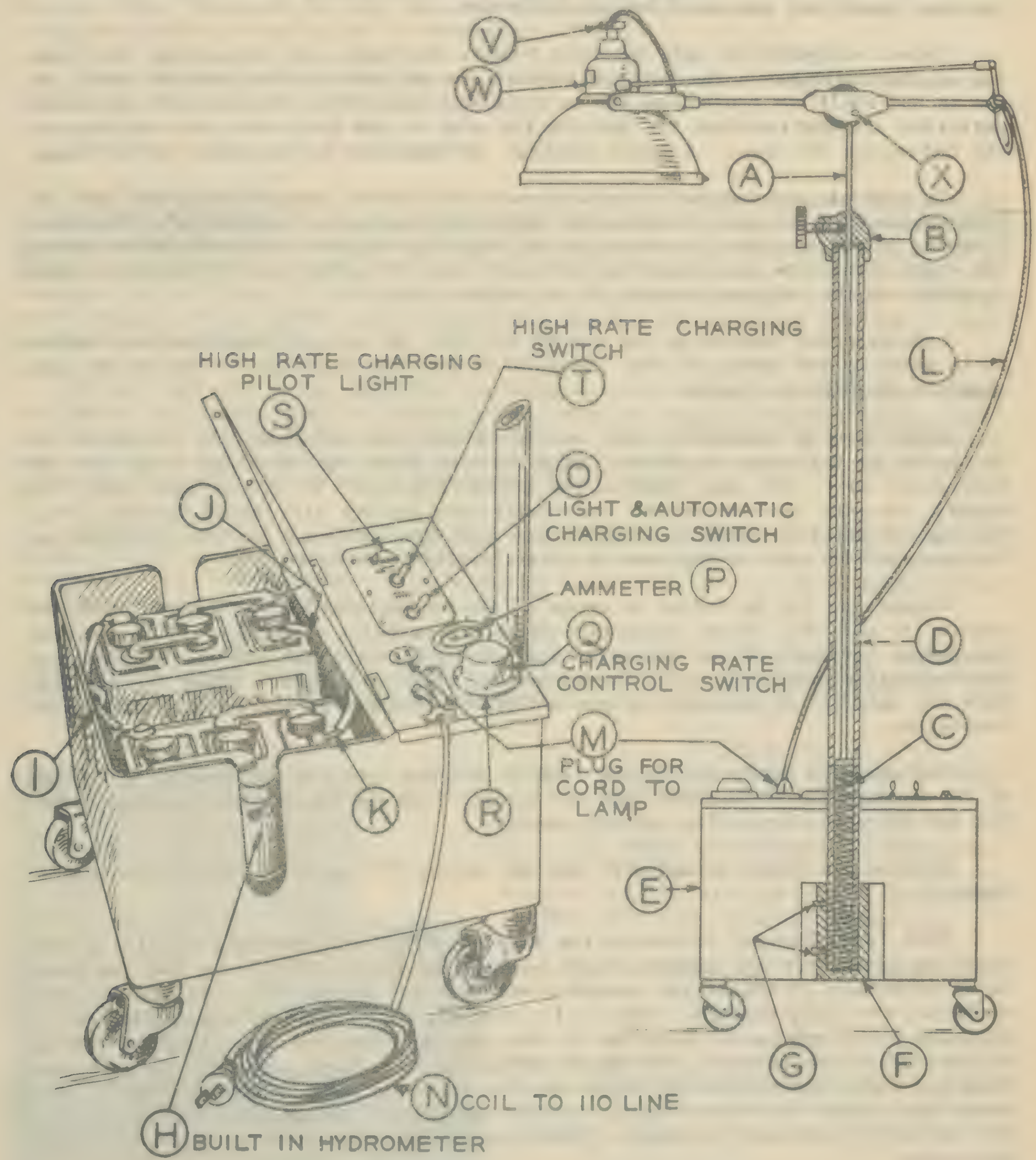


VIEW OF EMERGENCY UNIT



EMERGENCY OPERATING SPOTLIGHT CIRCUIT

*830 CASTLE LIGHT



INSTRUCTIONS FOR SETTING UP CASTLE EMERGENCY LIGHT NUMBERS 30 AND 830
(serial number higher than 5315)

FOR USE ON 110-120V. ALTERNATING CURRENT ONLY

Domestic shipment of the lamp is made in two boxes, the large box containing the lamp itself and the small box the batteries.

Export shipment is made in three boxes, the large box containing the lamp, one of the small boxes the batteries which are shipped without acid in them, and the second small box containing the acid for the batteries. Packed with the export batteries are instructions for putting the acid in the batteries and conditioning the batteries for use. A small package of vaseline is attached to the lamp.

To assemble the lamp slip the unthreaded end of the lamp standard 'D' into the base casting "F" and lock in place by tightening the two set screws "G". Put about 2 ounces of the vaseline lubricant in the top of this tube to lubricate the spring "C" which should now be slipped down into the tube "D". The tube "A" is now slipped in place and the reducing casting "B" is screwed down.

Lubricate the bearing at the top of the tube "A" and put lamp head on, locking it in place by the taper pin "X". Be certain that the taper pin is put in the side opposite the bakelite handle.

After lamp is assembled, open up the battery box and place the two batteries in the box as indicated in sketch. Be certain to place the batteries in so that the hydrometer slots "H" show THROUGH THE RESPECTIVE SLOTS IN THE BATTERY BOX. (On export, be sure that batteries are conditioned before placing in battery box.) The use of built-in hydrometer balls has been discontinued for the duration but battery position must be the same or polarity will be reversed.

Connect up the batteries by means of the connecting lead at point "I" and at points "J" and "K". These connection wires are so built that they will only reach the proper terminal if the batteries are put in as described above. Be sure that the terminal connections on the batteries are clean and tight. After the connections are made, it is desirable to put a little vaseline over the terminals to retard corrosion.

The cord "L" leading from the lamp is plugged into the receptacle "M" on top of the battery box "E" and the cord "N" leading from the battery box is plugged into the 110-120 volt alternating current supply.

To turn the light on and off, use the switch "O" marked "Light and Automatic Charger".

With fully bharged batteries the ammeter "P" should show practically a zero charging rate after the lamp has been burning one hour. If this is not the case, it is necessary to adjust the charging rate control switch "1". Be certain that batteries are fully charged. (When fully charged, batteries have a specific gravity of 1.220.) If hydrometer balls are in the slot both Red and White balls should be at the top of the channel. If export batteries have been supplied, be sure that they are fully charged before adjusting the charging rate control switch to zero capacity. Follow the directions given for the initial charge specifically so that the battery is properly charged. Charging instructions are packed with export batteries.

The charging rate control switch "Q" is covered by a cap "R" which is held on

to the top of the box by three screws. Take out the screws and lift off the cap to gain access to the switch and with the lamp plugged into your current supply and the Light and Automatic Charger switch "O" in the "on" position, turn this switch to the right or left until the charging rate is approximately zero or slightly on the charge side. Replace the cap over the charging rate control switch as further adjustment will probably not be necessary.

This charging rate control switch is simply a device to regulate the current accurately to local line voltage conditions.

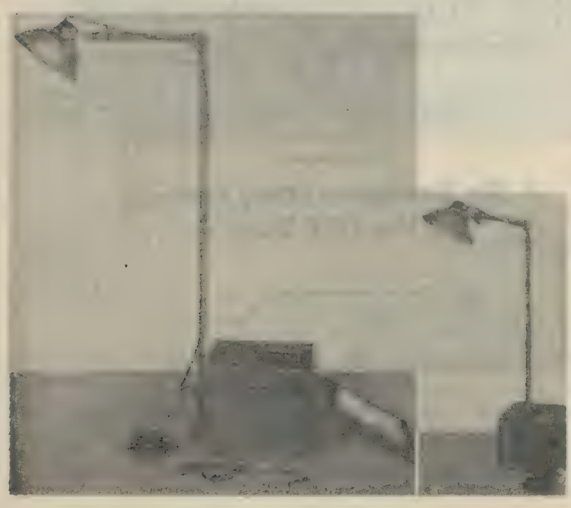
The lamp is now ready for service.

The high rate charging switch "T" is only used in case it becomes necessary to recharge the batteries in an abnormally short time of a few hours, which would only be occasioned when the batteries were run down badly through emergency usage. Complete recharging can be accomplished in from five to seven hours with this high rate charger. A red light "S" will light when the high rate charger is on. The high rate charger should not be on for more than twelve hours at one time as it will overcharge the batteries.

Normal charging of the batteries is taken care of through the automatic charging device which regulates the charging rate when the lamp is lighted between zero and 10 amperes in accordance with the condition of the battery. This is automatic and requires no regulation after the charging rate control switch is properly adjusted.

The bulb used is a 12 volt, 80 watt special bulb which is obtainable from the Wilmot Castle Company and their dealers, or from Westinghouse Electric Company or the General Electric Company. It is known as an 80 watt, 12 volt, P-25 double filament hospital spotlight bulb.

Focusing of the lamp so that the desired intensity can be obtained is accomplished by rotating bakelite knob "V" on the top of the lamp head. To remove the bulb turn cap "W" a short counterclockwise turn and lift out.



DIRECTIONS
LAMP, OPERATING, FIELD (Item 99315)
TO UNPACK AND ASSEMBLE

1. Insert non-threaded (copper end) upright in outside channel; pin-heads in slot at 45° to side of box. Then lock upright by a short turn clockwise.

2. Screw 2nd and 3rd uprights into each other.

3. Screw 4th upright (with 2 hooks the one nearest hinge side of box) into No. 3. Big hook is for intravenous bottle. Point it away from box. Screw cross arm (like Nos. 2 and 3) into No. 4.

4. Loosen inside clamp over lamp head, and lift out lamp head carefully, Screw its "T" handled bushing into cross arm.

5. Open water seal caps at front and insert 3 point plug on cord from lamp through inner hole. Tighten water seal cap on this cord.

6. Connect 3 point plug from lamp to proper receptacle according to chart.

7. Refer to chart and, if needed, select 3' or 20' power cord (from corner of box). Insert female plug from outside, through outer water seal hole and tighten water seal cap. Attach female plug according to chart.

TO OPERATE

1. For 110V A.C. or D.C. and 220V A.C. or D.C. insert female plug on 20' power cord to male power receptacle "P" in extreme corner of box. Attach male end to power supply.

2. For 110V A.C. or D.C.

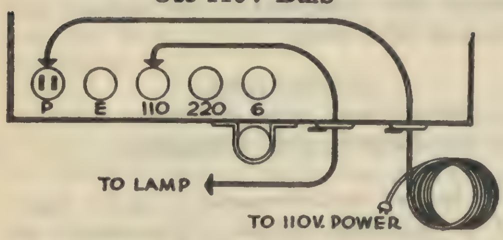
   a. Select 110V bulb from partition. Place this in lamp. Socket is exposed by giving cap a slight turn counter-clockwise.

   b. Plug 3 point cord from lamp into receptacle marked 110V. Light is then in operation. Direct beam as desired.

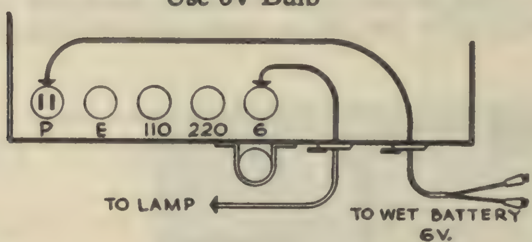
CHARTS FOR WIRING CONNECTIONS

CODE:	
"P"	Power Input
"E"	Emergency Batteries (Dry)
"110"	110-220V, A.C. or D.C.
"220"	220-240V, A.C. or D.C.
"6"	6V Storage Battery (Wet)

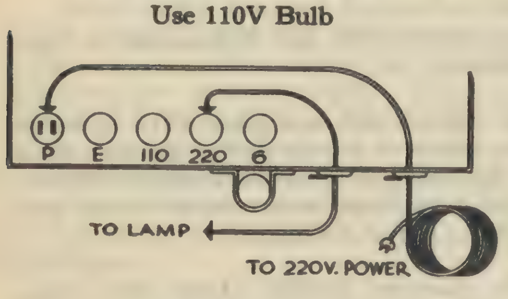
2 For 110V A.C. or D.C.
Use 110V Bulb



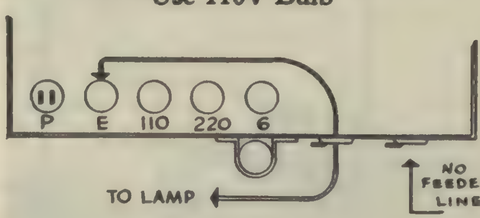
4 For Storage (Wet) Battery
Use 6V Bulb



3 For 220V A.C. or D.C.
Use 110V Bulb



5 For Emergency (Dry) Batteries
Use 110V Bulb



3. For 220V A.C. or D.C.

   a. Use 110V bulb as above.

   b. Plug 3 point cord from lamp into receptacle marded 220V. Light is in operation. Direct beam as desired.

4. For (Wet) Storage Battery Power. (Battery not in this outfit.)

   a. Remove 110V bulb from lamp head. Select and insert 6V bulb and adaptor.

   b. . See that short 3' power cord is inserted through water seal cap, that female plug is connected to male power receptacle in "P" in corner of box, and that rubber capped clips on other end of that cord are attached to battery terminals outside box.

   c. Plug 3 point cord from lamp into receptacle marked "6V". Light is then in operation. Direct beam as desired.

5. For Emergency (Dry) Battery.

   a. Use *neither* long (20') nor short (3') power cords. Leave them coiled in front left corner of box.

   b. Select and insert 110V bulb in lamp.

   c. Plug 3 point cord from lamp into receptacle marked "E" or "Emergency". Light is then in operation. Direct beam as desired.

6. Close cover to make water-tight.

TO DISASSEMBLE AND PACK

1. Remove cover.

2. Remove short or long power cord, pulling it out through water seal cap.

3. Remove lamp head cord from inside receptacle and water seal cap.

4. Unscrew lamp head and coil cord around top.

5. Lift up cross-bar clamp and strap; place lamp head, glass down, on triangular platform in box, so that rim is inside channel guides, with "T" bushing to rear.

6. Coil power lines and place in corner of box.

7. Unscrew and take down uprights. Bottom one is loosened by slight turn counter-clockwise.

8. Place 4th upright (with hooks) into last groove, with elbow resting in deep pocket. Place other sections in remaining grooves with handles down.

9. Replace outer water seal caps.

10. Lower strap over uprights; clamp lamp head in place by cross-bar.

11. Clamp down oover.

SPARE PARTS - DRY BATTERIES

Extra Cover Glass is in compartment inside cover.

Bulb for 110V or 220V or "B" (Dry) Battery is the same in this adaptation. This is Marine Running Lamp, Federal Stock Item 17-L-4392 with two 50W filaments, Mogul base. Mogul to medium adaptor also supplied for use with ordinary 50W bulb (not recommended).

Bulb for 6V wet battery is 6-8V-50 CP single contact, bayonet base, Mazda No. 1183; Stock Item No. 17-L-5100, sub-item N-148, as used in automobile spot and fog lights, with adaptor for storage battery use.

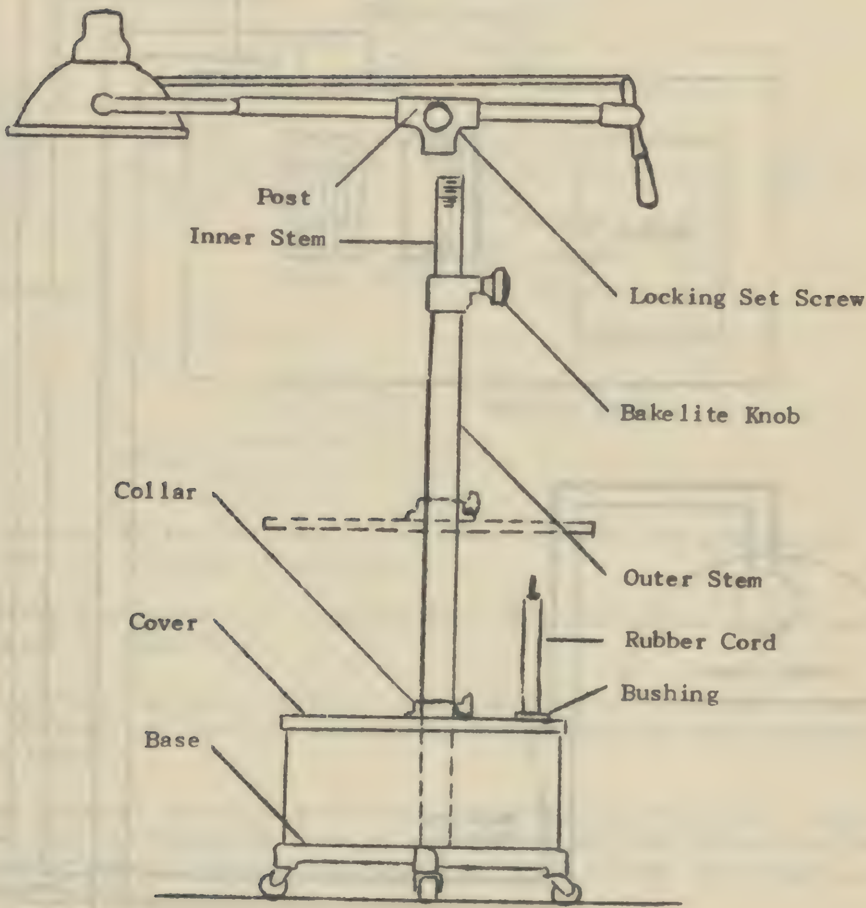
"B" Batteries (three) are removed by pulling ring on knee action clamp at front box. This loosens triangular plate which may be removed. Be sure to replace securely.

"B" Batteries are in General Supply Catalog V30F16-B3300 battery which is a No. 650 Usalite battery made by U.S. Electric Manufacturing Corporation, and V30G16B-3310 which is a P8303 Ray-O-Vac battery made by the Noland Co., Inc. Connect batteries in series, using only end terminals. Connections between batteries to be plus to minus.

EMERGENCY OPERATING SPOTLIGHTS

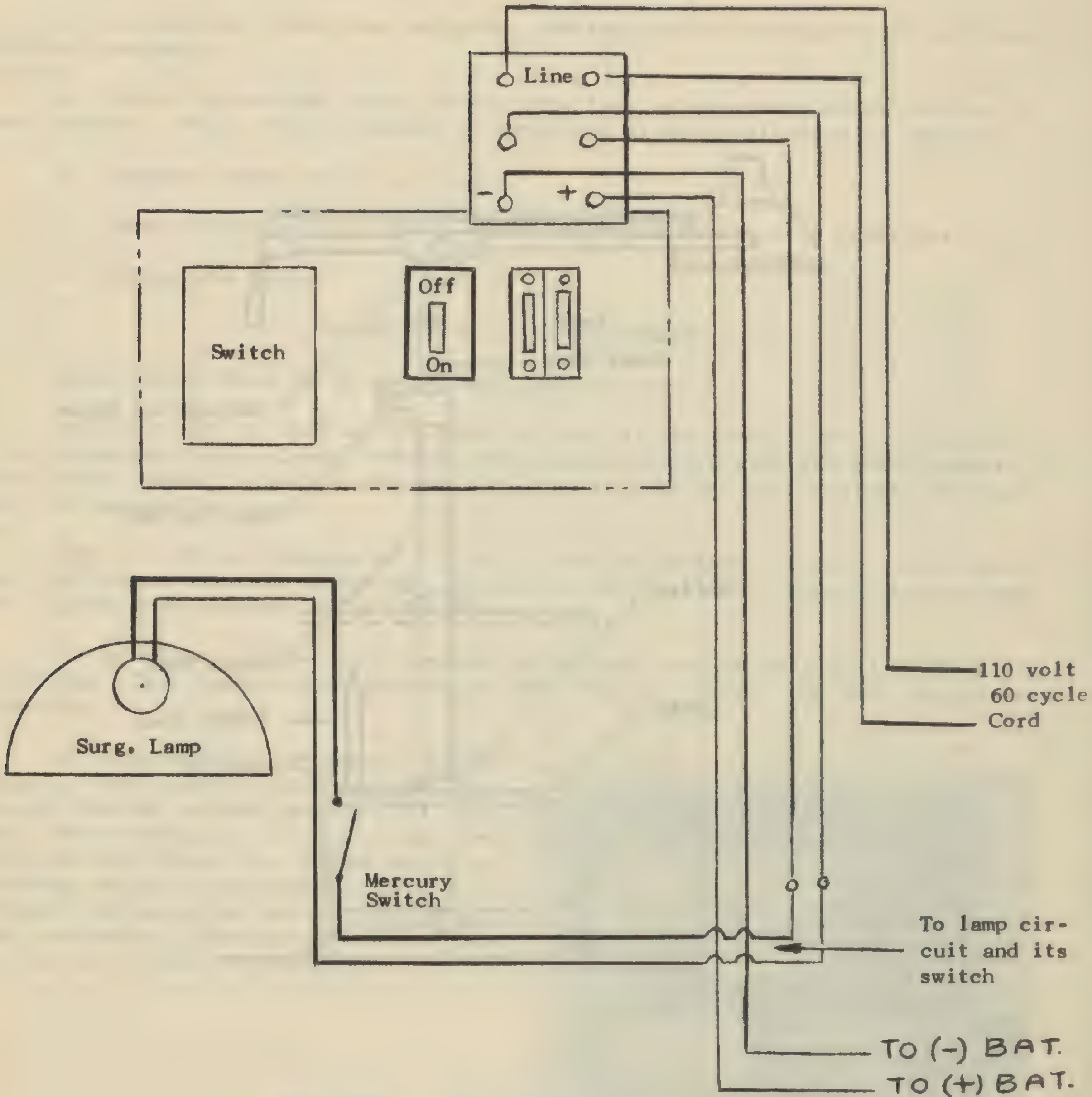
MODEL ADRT PORTABLE EMERGENCY LUMINAIRE

AMERICAN STERILIZER CO.



INSTRUCTIONS FOR ASSEMBLING

Screw Outer Stem into Base (thru Collar and Cover). Make certain Outer Stem is tight in Base. Cover can be lifted up on Outer Stem to expose unit in box. Thumb Screw in Collar can be tightened to hold Cover up. The Bakelite Knob in Collar or Outer Stem is tight to prevent Inner Stem from falling into Outer Stem. Hold onto Inner Stem, loosen Bakelite Knob, lift up Inner Stem and screw Inner Stem into Post. Lock with Locking Set Screw. Thread Rubber Cord thru Bushing in Cover and make connections to unit in Box. Lower cover and lock. Unit is now ready for use.

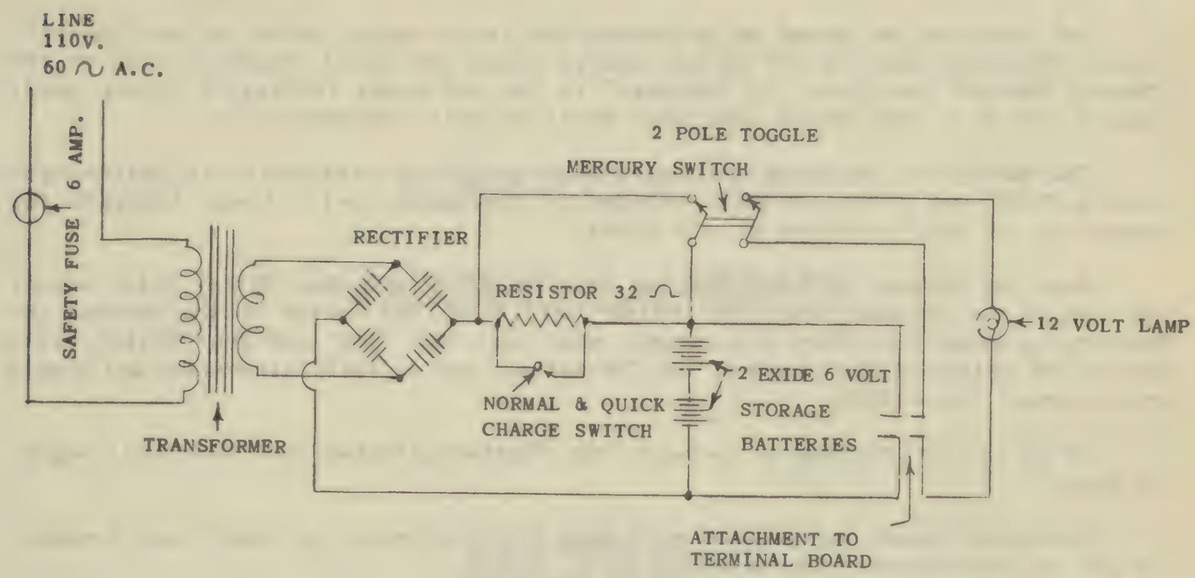


WIRING DIAGRAM

AMERICAN PORTABLE EMERGENCY LUMINAIRE
AMERICAN STERILIZER COMPANY

EMERGENCY OPERATING SPOTLIGHTS

INSTRUCTIONS FOR SETTING UP AND OPERATING PROMETHEUS LIGHT #178-F
THIS LIGHT IS TO BE USED ON A.C. CURRENT ONLY



SERIAL #

Lamp is shipped in two sections. The base, housing and upright are in one case and the head of the lamp in another.

The Batteries are packed in a separate box, that chemicals may not spill onto the lamp mechanism in transit,

After unpacking lamp and batteries, raise up cover of lamp housing and place the batteries therein, so that the hydrometer balls face the open windows in the housing of the lamp.

Place the "Jumper" onto the batteries, the "Red" or "Positive" end of the "Jumper" to the "Red" or "Positive" side of one battery and the "Black" or "Negative" end of the "Jumper" to the "Black" or "Negative" side of the other battery; this connects the two batteries in series.

To mount the head of the lamp, raise the inner tube of the stand about six inches, and fasten clamping screw, then place socket on lamp head bar over this tube and tighten set screws.

The cable coming out of the bar of this head is passed thru the bushing in the rear of the Battery housing and bolted onto terminals on panel board inside of the housing marked "Lamp": it makes no difference which terminal is used for either connection.

From the Panel Board extend two cables, marked "Plus" (+) and "Minus" (-) the "Positive" or Red cable is fastened securely to the "Positive" or Red terminal of the "Battery" and the "Negative" or Black terminal is fastened to the "Negative" or black terminal of the battery.

After Battery connections have been securely made, place some vaseline onto the terminals; this prevents corrosion, resulting in poor conductivity.

Plug the cable leading from the back of the battery housing into a convenient outlet (110 V. A.C., it will not function on D.C.) and lamp is ready to use.

The light may be turned on by placing the large toggle switch to the "On position; When the lamp is not in use alsays place the small toggle switch on the "Normal Charge" position. If "Battery" is low and needs recharging place small toggle switch to the "Quick Charging" position until charged.

The Batteries supplied with this Operating lamp have built-in Hydrometers with a "Red" and a "White" hall located in the center cell, these indicate the condition of the batteries at all times.

When the battery is fully charged both the "Red" and the "White" balls are at the top of the chamber; when the "White" ball is at the bottom of the chamber the Battery is about one-third discharged, when both the "Red" and the "White" balls are at the bottom of the chamber, the "Batteries" are entirely discharged and should be recharged immediately.

It is better practice to recharge the "Batteries" when the "Red" ball begins to drop.

Batteries should be refilled with pure distilled water at least once a month. Do not use the ordinary tap water.

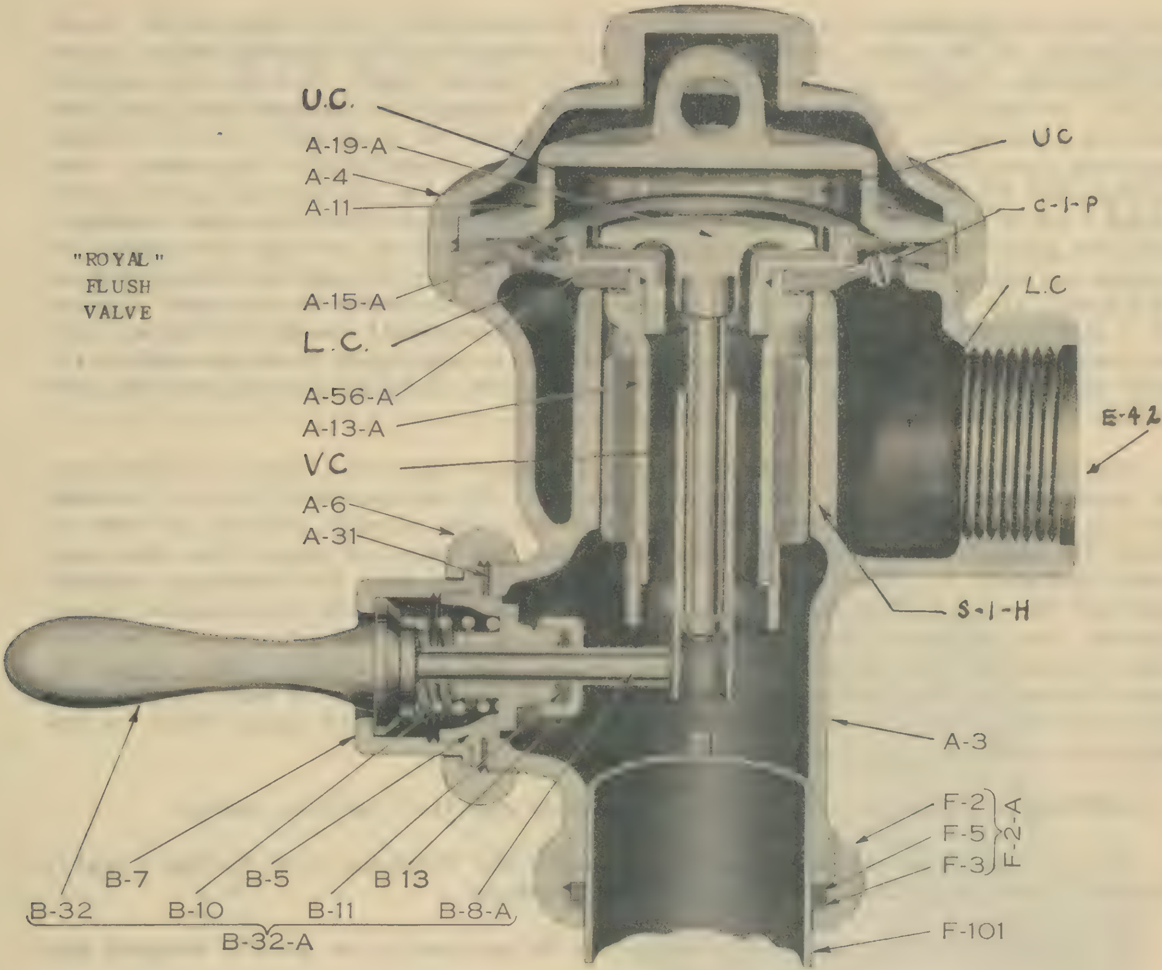
To get highest efficiency out of this light, keep batteries fully charged, by leaving cord plugged in when not in use and toggle switch on the "Normal Charge" position.

When battery is fully charged current consumption on the line is low.

CHAPTER XII
MISCELLANEOUS

SECTION 1
FLUSH VALVES

"ROYAL"
FLUSH
VALVE



PURPOSE - These valves are commonly used to flush toilets, hoppers, bed pan washers, etc. The purpose of the valve is to automatically deliver a predetermined volume of water to the receptacle to be flushed. As far as the operator is concerned, the only action necessary is to trip the flush valve handle.

"ROYAL" FLUSH VALVE

OPERATION - This valve is known as a Diaphragm type. By referring to illustration it will be noted that the water supply is connected to valve entry (E-42). When the water supply is turned on, the water flows into the lower chamber (L.C.) and through the orifice (C-1-P) in the diaphragm into the upper chamber (U.C.). Thus there is an equalized pressure in both chambers. This is the normal condition of the valve when not functioning.

When it is desired to operate valve, the trip lever (B-32) is pushed in any direction convenient. In so doing the plunger (B-8-A) is forced against the telescopic sleeve on the stem of auxiliary valve (A-19-A), pushing the valve stem sideways, thus unseating the valve and permitting water in the upper chamber (U.C.) to flow past the valve head (A-19-A) and down through the valve chamber (V.C.) and

so on into the receptacle to be flushed. At the same time, since there is no longer any pressure in the upper chamber (U.C.), the pressure of the incoming water forces the diaphragm (A-15-A) up from its seat on the hollow shaft (S-1-H), and permits the full volume of the incoming water to flow through the hollow shaft and thus flush the receptacle. It must be noted that it takes but a second or so to release the water from the upper chamber (U.C.) when the flush handle is pushed, thus starting the flushing operation. As soon as the handle is released, the valve (A-19-A) falls back on its seat, thus closing the outlet from the upper chamber. While the greater volume of the incoming water is passing through the valve for flushing purposes, some of this water is forcing its way through diaphragm orifice (C-1-P) into the upper chamber (U.C.)- As soon as the pressure in the upper chamber (U.C.) equals that of the incoming water, the diaphragm will resume its normal concave contour; this plus the weight of the interior auxiliary valve assembly will reseat the diaphragm on the shoulders of hollow shaft (S-1-H), shutting off the flow of water to the receptacle.

The trip mechanism is so designed that it cannot cause the valve to flush more than once without the trip lever being released. If the operator fails to release the trip lever, the following cycle occurs: when the plunger (B-8-A) is made to contact the auxiliary valve stem, thus permitting the water to escape from the upper chamber and start the flow of water, it will be recalled that the Diaphragm assembly rises and the valve stem and sleeve clear the plunger. If the trip handle is not released, the telescopic valve sleeve will rest on top of the plunger as the diaphragm settles at the end of the flushing period, and it is obvious that, since the sleeve is now resting on top of the plunger, the valve cannot be made to function until the trip lever is released, permitting the sleeve to again fall to the operating position.

SERVICE - There is very little servicing required on this valve.

Should the valve fail to flush or should the flushing time become greatly increased, one should look for the following troubles:

1. The diaphragm orifice (C-1-P) may be partially or wholly stopped up.

2. The auxiliary valve seat may be leaking, which would make it impossible for pressure to build up in the upper chamber.

3. The Diaphragm may be ruptured, which would also prevent pressure being built up in the upper chamber.

4. If the valve continues to flush while the handle is held down, it is probable that the auxiliary valve stem sleeve has become fast to the stem. This can be remedied by taking the valve apart and loosening it.

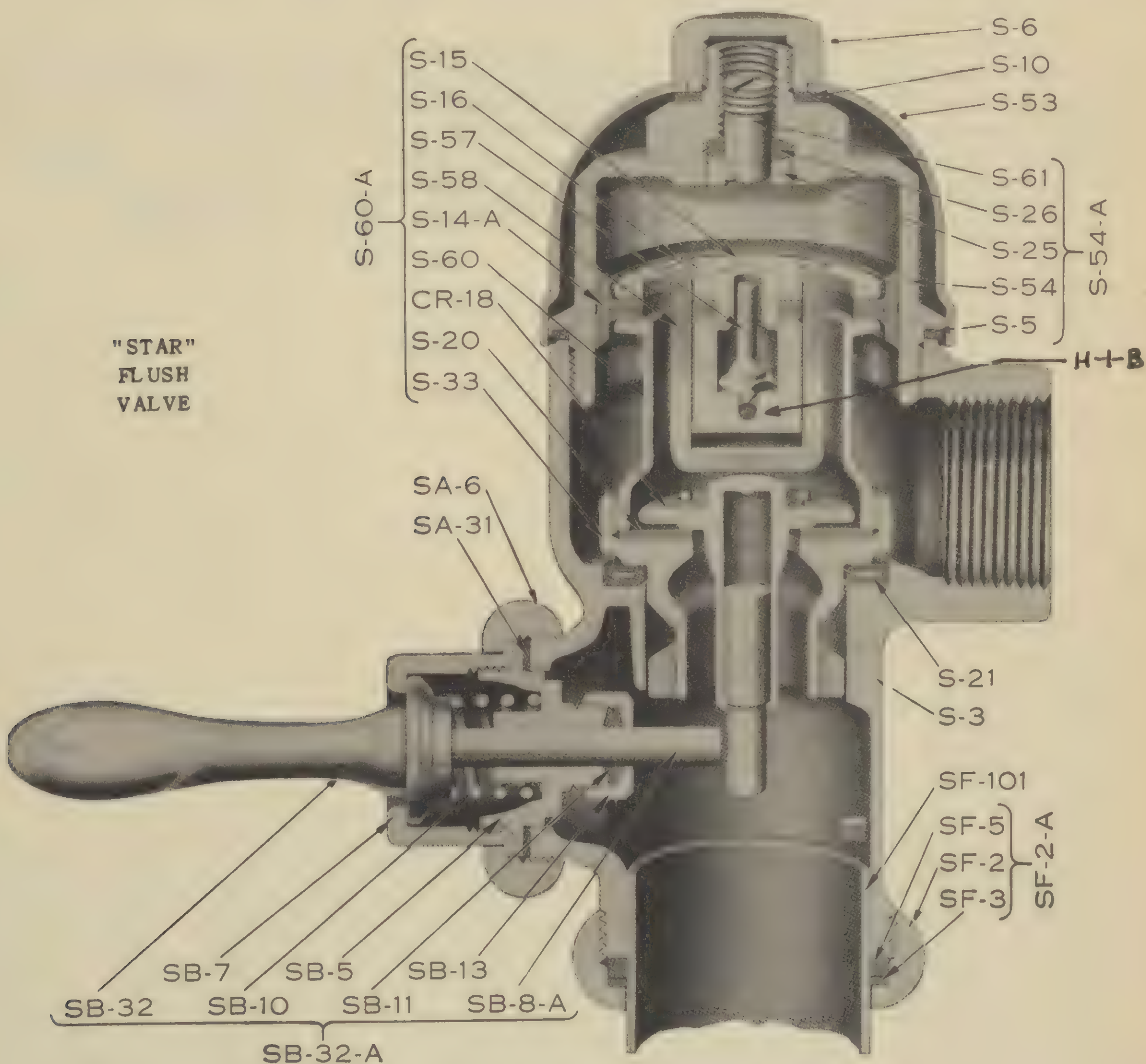
If the diaphragm orifice (C-1-P) is choked, the obstruction may be removed either by blowing the obstruction out or by forcing it out with an instrument suitable for the purpose. Care should be used while attempting the latter to make sure that the orifice is not enlarged during the process; however, should this happen, it may be remedied by a light tap with a hammer.

"STAR" FLUSH VALVE

OPERATION - This valve is known as a piston type. The "Star" valve operates in a somewhat similar manner to the "Royal", the chief difference being that the "Star" uses a piston in place of the diaphragm found on the former.

The handle plunger assembly is the same as that on the "Royal", the auxiliary valve is also similar with this exception. On the "Royal" the plunger engages the sleeve of the valve stem, while on the "Star" the plunger engages the stem itself. The stem in this case telescopes into the hollow sleeve of the valve.

The water supply enters this valve at the threaded connection, passes into the lower chamber and through orifices (H-1-B) into the upper chamber, thus as in the "Royal" valve, an equalized pressure is established in both chambers. The upper chamber on this valve extends down through the holes in piston head (S-15) to auxiliary valve head (CR 18). When flushing handle (SB 32) is pushed, the auxiliary valve (CR 18) is tilted and the upper chamber empties past valve head (CR 18) and seat (S-20). The incoming water then forces the piston assembly to rise, lifting the main valve off seat (S-21) and allowing the flushing water to pour into the receptacle to be flushed. At the same time the auxiliary valve is again seated, water forces its way into the upper chamber through orifice (H-1-B) until the



"STAR"
FLUSH
VALVE

pressure in the chamber is equal to that of the incoming water. This causes the piston assembly to reseat itself on seat (S-21), cutting off the flow of water to the receptacle.

ADJUSTMENT - It will be noted that when the piston assembly is forced to top of chamber, the check valve (S-57) will rest against the set screw (S-61). The water entering the upper chamber can go through the orifice (H-1-B) only as fast as the check valve (S-57) will allow. By changing the adjustment of the set screw, the time required for the upper chamber to fill and the flush to be shut off will also be changed. Thus as the set screw is turned clockwise or downwards, the length of the flushing period will be increased, since the flow of the equalizing water is cut down by the check valve being held closer to the orifice and thus restricting its size. Conversely, as the screw is turned counter-clockwise or upwards, the flushing time is diminished since the check valve is permitted to open completely and thus the water can flow in faster.

Should the handle be held down, the valve is kept from flushing more than once by the same principle as described for the "Royal" flush valve.

SERVICE - Most of the service required for this valve will be concerned with the composition piston ring (S-14-A) in the piston assembly and the composition valve seats (S-20)and S-21). These may be readily replaced if necessary. In very rare instances the orifice (H-1-B) may become obstructed, in which case it would be necessary to disassemble the valve and clean. Should leakage appear around adjusting screw (S-61), the packing (S-26) may be replaced.

CHAPTER XII

MISCELLANEOUS

SECTION 2

PRESSURE AND SUCTION PUMPS

PRESSURE AND SUCTION PUMP - This is a machine that, as its name implies can generate either positive or negative pressure. The range of pressures are approximately from 1# to 25# positive and from 0 to 24 inches negative. The primary working parts comprise an electric motor driving one or two pumps. When a single pump is used it is capable of generating both positive and negative pressures. When two pumps are used, one is used for generating the positive pressure, the other for negative pressure. The pumps on most machines are of rotary type. For description see under "Service to pressure and suction apparatus". Various control valves and accessories are incorporated in the apparatus.

PURPOSE FOR WHICH A SUCTION AND PRESSURE PUMP IS USED - Units of this type are usually found in the Surgery and in the offices of E.E.N.&T. Specialists. The positive pressure is generally connected to spray bottles, ether jars, etc. When the pressure is applied to a Spray bottle it will of course exert a pressure on the liquid in the bottle and cause it to be ejected through a nozzle thus vaporizing or nebulizing the liquid. In this case the atomized or nebulized liquid is used for spraying surfaces to be medicated.

The use of pressure on an ether bottle (which is generally kept at slightly higher than room temperature, in order to vaporize the ether) has practically the same results. The ether vapor is forced out of the bottle and is conducted either down the patient's throat or through the patient's nostrils and thus to the lungs, the object being to induce anesthesia. Anesthesia is frequently administered in this way for such operations as tonsillectomies and adenoidectomies.

Negative pressure or vacuum is used for suction purposes, such as keeping the operating field free from blood or mucus by sucking the blood or mucus from the site, and collecting it in a glass jar or reservoir. The glass jar or reservoir is located between the end of the suction tube and the pump, so that all blood, etc. sucked up at the nozzle is drawn into the reservoir before it can reach the pump.

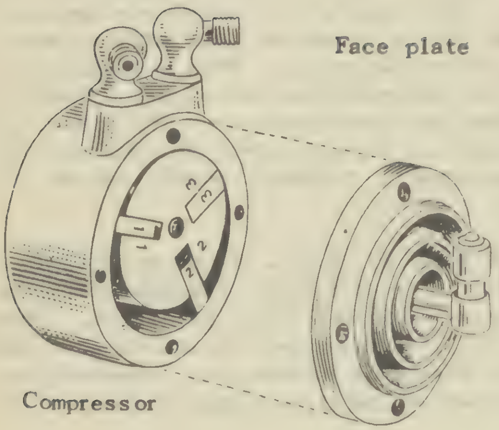
PRESSURE AND SUCTION PUMP PARTS, ETC.

OPERATION - The pumps are driven by an electric motor ranging in h.p. from 1/10 to 1/6 h.p. The more modern motors are frequently vapor proof and marked as such, i.e.

Class 1 - Group C -- Ether vapor.
Class 2 - Group D -- Gasoline vapor.

The motors are either mounted on springs or rubber cushions to eliminate noise and vibration.

PUMP OR COMPRESSER - Is of the rotary high pressure type. The rotor of the compresser is mounted with a steel key on the motor shaft and has three or four oiless bronze or bakelite slides operating in milled grooves or rotor without the use of springs or valves. By refering to the sketch, it will be noted that the rotor is mounted off center with the pump body and is of a smaller radius than the pump body, thus only about one fifth of the external periphery of the Rotor will at any one time come in close approximation with the internal periphery of the pump body. As the rotor turns centrifugal force tends to eject the rotor blades from their grooves so that they are at all times in direct contact with the internal periphery of the pump body. As the pump turns the blades are carried around at a high speed and it will be readily seen that in the case of a double action pump air will be forced out at one outlet and drawn in at the other. In the case of a single action pump only one outlet from the pump is provided so placed as to either pump air out or draw it in.



To clean this pump it is only necessary to remove the face plate and ready access to the parts to be cleaned will be obtained.

GAUGES - These are provided to indicate pressure and vacuum. Regulating valves are provided to regulate amount of pressure or vacuum delivered.

FILTERS - A filtering system is provided comprising one filter incorporated in the pressure system and one in the suction system. These filters have replacable filtering units. 2" gauze bandage is generally used for these.

HOSE COUPLINGS, ACCESSORIES, ETC. - These include hose couplings, hose, connecting tubes, bottles, etc.

SERVICE TO PRESSURE AND SUCTION PUMP - Probably the greatest source of trouble on this type apparatus is caused by neglect on the part of the operator to properly care for the machine. A careless operator will quite frequently allow the suction pump to keep on running even after the reservoir is filled to its limit; as a result, blood, mucus, moisture etc. is sucked into the body of the pump and if not immediately cleaned out it will coagulate and cause the rotor blades to stick in the rotor, thus making it impossible to either create pressure or draw a vacuum. In bad cases where the pump is allowed to remain idle over a considerable length of time without being cleaned after foreign matter has been sucked into it, the rotor may even become frozen to the inside of the pump body, and unable to turn. Since the rotor is connected directly to the motor this may cause the motor to burn out when current is turned on.

TYPICAL PRESSURE AND SUCTION APPARATUS

If the blades of the rotor are not stuck too badly and the motor will turn over fairly easily, the best thing to do is to disconnect tubes and fittings as close to the pump as possible. Then take kerosene or gasoline in an oil can and put quite a little in on the vacuum side of pump while running. Continue this procedure until sure the blades will or will not free themselves. If they do loosen up, repeat the same procedure using machine oil until the pump seems to be operating in the proper manner. Then let pump run for half or three-quarter of an hour to be sure it is functioning properly. However, if the motor will not turn, it will be necessary to dismantle the pump by removing the face plate and loosen up the rotor and rotor blades and thoroughly clean all internal parts of the pump. When reassembling pump, make sure all contact surfaces are clean and fitted together properly, this is essential in order to assure an air tight joint. Use a thin shellac as a "sealer" when reassembling pump face plate.

Other service points include the care of the various control valves. There is a ball check valve to hold the vacuum; if it fails to hold, the seat will need cleaning. There are also needle or slotted valves located on vacuum and pressure filters that regulate the amount of pressure or vacuum delivered. These valves should of course be kept clean and seating properly. Filters with removable gauze filtering elements (generally 2" bandage gauze is used) are included, one on the pressure side to filter any impurities from the air before it reaches the atomizer and one on the suction side to prevent foreign bodies, moisture, etc. being sucked into the pump. The filtering elements should be changed as needed.

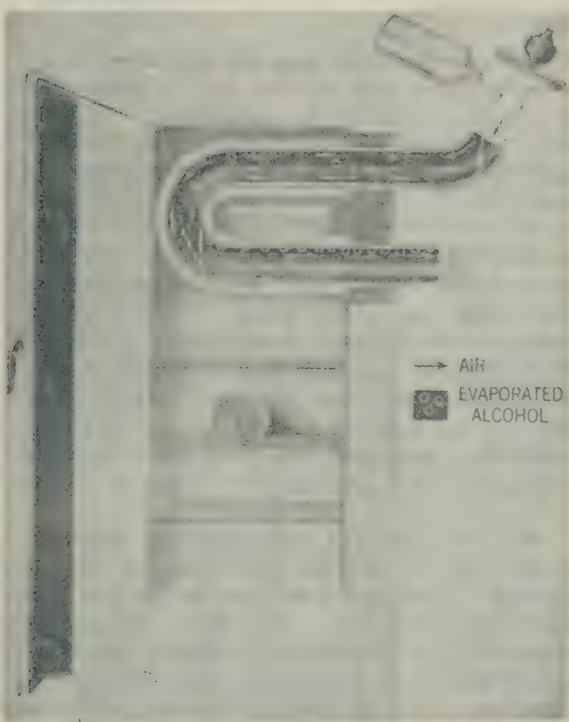
CHAPTER XII
MISCELLANEOUS

SECTION 3
GAS REFRIGERATORS

EXPLANATION OF GAS REFRIGERATORS - Pour some alcohol (rubbing alcohol or wood alcohol will do) on the back of your hand. Blow on the alcohol. This spot will feel real cool. Now blow on your other hand where there is no alcohol. It will not feel cool, but warm. What happened when you blew on the alcohol? Liquid alcohol was swept by a stream of warm air and the result was a temperature below the temperature of either the alcohol or the air. In reality this simple process produced refrigeration.

As the air sweeps past the hand, the alcohol disappears. It evaporates into the air. Cold can be produced by evaporation of a liquid. You proved this by blowing on the hand that has alcohol on it. You could feel the cold. You will be surprised how much cold can be produced in this way. Pour some alcohol in the hollow of your hand and place a thermometer bulb in the liquid. Then as you blow on the alcohol watch how quickly the mercury drops. If you could blow continuously and had a continuous supply of alcohol poured into your hand you would be producing continuous refrigeration.

A SIMPLE REFRIGERATOR - We have seen that evaporation can produce a cooling effect. How can we use this evaporative cooling effect in a refrigerator box? We need a supply of alcohol and a flow of air. Of course the alcohol should not evaporate directly into the air in the refrigerator. Flow suggests pipes. So let us run an ordinary metal pipe through the box and have the alcohol and air flow through the pipe. A metal pipe is a good conductor. Consequently the cold produced by evaporation in the pipe is directly used to refrigerate the contents of the box.



Evaporation can take place in a pipe by letting alcohol trickle down the pipe while a slow breeze of air passes over the liquid alcohol. Such a pipe is an "evaporator". If the evaporator is placed in an insulated enclosure we have a simple refrigerator.

So we place a loop of pipe in the box and pass the ends through the insulation of the box. If we pour liquid alcohol into the pipe so that it flows down through the pipe, and if we pass a current of air through the pipe, we will have evaporation within the pipe and the box will be refrigerated. As the alcohol evaporates into the air, a gaseous mixture of alcohol vapor and air is formed in the same way as when you blew on the alcohol in your hand. We have made a simple refrigerator.

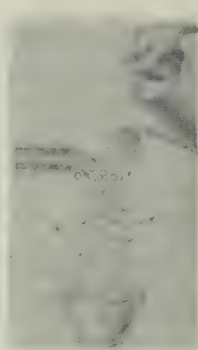
If we place a tray containing water on the pipe, we could produce ice.

The evaporator is the part of the refrigerating "system" which is inside the refrigerator box. There are other parts to the system, but they are outside the insulated food space. They serve to make the process continuous, automatic, and economical.

The evaporator of the Gas refrigerator is made up of a number of loops of pipe arranged in the walls of "chest" for ice drawers and also exposed to directly cool the food space.

RECLAIMING THE EVAPORATED LIQUID - A mixture of alcohol vapor and air leaves our experimental evaporator. If we are to use the alcohol over again, we must first separate it from the air. This is easily done if we dissolve the alcohol in water. We know that water dissolves alcohol but does not dissolve air. A rain shower clears the air, actually washes it, but does not dissolve the air.

So let us sprinkle water into the mixture of alcohol and air leaving the evaporator. The shower of water washes the alcohol out of the air and the alcohol becomes dissolved in the water. This is what is known as "absorption". Since we are doing this to save the alcohol, we will collect the water with the alcohol dissolved in it in a "bowl".

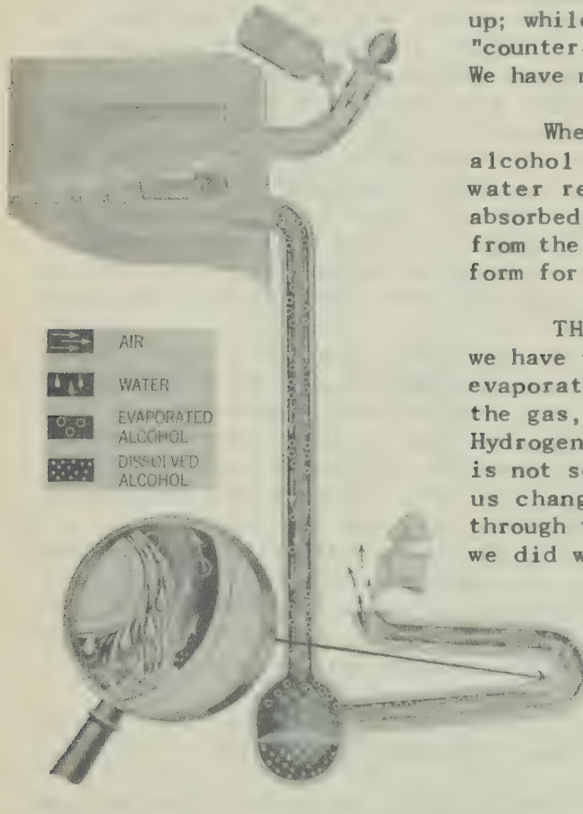


For simplicity, we can use another pipe for this "absorption", with the bowl at the lower end of the pipe. Of course, we must connect our new pipe and "bowl" to the evaporator. If we make the connection to our "bowl", the mixture of alcohol vapor and air will flow up; while the water flows down. This "counter-flow" gives good absorption. We have made an "absorber".

When the air reaches the top of the absorber, alcohol has been washed out of the air. When the water reaches the bottom of the absorber, it has absorbed alcohol. We have now segregated the alcohol from the air and have the alcohol in a readily usable form for reclamation.

THE EVAPORATOR-ABSORBER CIRCUIT - So far we have used air as the "gas" into which the alcohol evaporates. We could use other gases. The lighter the gas, the easier the alcohol evaporates into it. Hydrogen is the lightest gas and, at the same time, is not soluble in water and does not rust metal. Let us change from air to hydrogen and blow hydrogen through the evaporator and into the absorber, just as we did with the air. The action will be the same.

When we used air, which costs nothing, we could let it escape from the top of the absorber. But when we use hydrogen, we cannot afford to waste it. When it reaches the top of the absorber, alcohol has been removed and the hydrogen can therefore be used again. So let us connect a pipe from the tip of the absorber to the top of the evaporator, so the hydrogen can pass back to the evaporator.

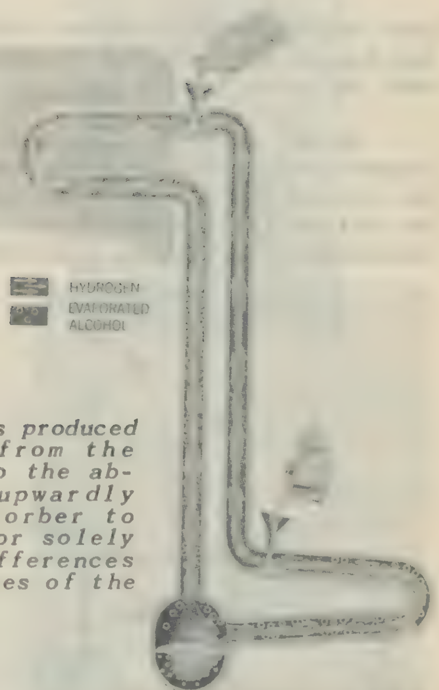


We "wash" the alcohol out of the air. The water absorbs the alcohol but not the air. The dissolved alcohol is collected at the bottom of the absorber.

We have now made a circuit for the hydrogen through the evaporator, from the evaporator down to the absorber, up through the absorber and back to the evaporator.

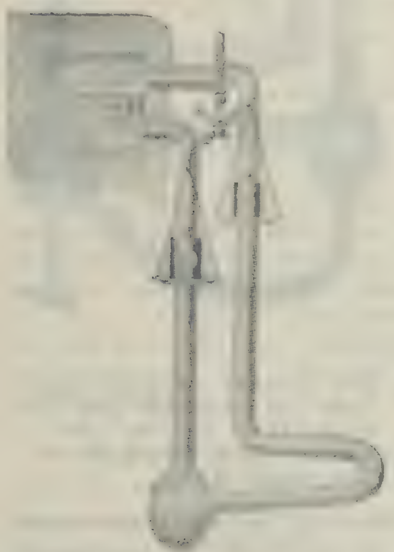
When we used air it was easy to produce a "breeze". Even our lungs could provide the motive power, But, of course, when we change to hydrogen and close the circuit, we must supply some other force for producing a flow around the circuit.

We connect a pipe between the top of the absorber and the evaporator to make a circuit for gas.



Circulation is produced downwardly from the evaporator to the absorber and upwardly from the absorber to the evaporator solely by weight differences in the branches of the circuit.

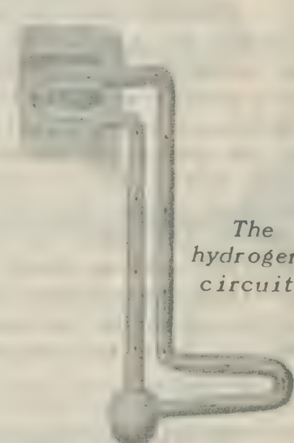
It might be thought that a fan could produce the breeze of hydrogen. But we can apply a natural circulating force and eliminate moving parts because we have different gas conditions in different parts of the circuit. A mixture of alcohol vapor and hydrogen is heavier than hydrogen alone. As we have arranged the circuit, there are two vertical branches or columns: the heavier gas is in the down-flow pipe from the evaporator to the absorber and the lighter gas is in the up-flow pipe from the absorber to the evaporator. The heavier gas mixture produced in the evaporator therefore flows down by gravity and the lighter gas (the freed hydrogen) resulting from the absorption of the alcohol in the absorber must go up; just as the heavy side of a balance goes down and the light side goes up.



The circulating force is analogous to difference in weights on a balance scale The preponderance of weight on one side makes the gas go down on that side and up on the other.

In effect, the heavy gas mixture flows by gravity from the evaporator through one pipe into the absorber and pushes the light hydrogen up in the absorber and back through the other pipe to the evaporator.

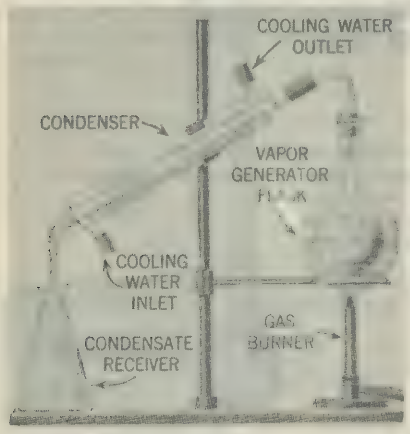
As long as we supply alcohol to the evaporator and water to the absorber, the heavy gas mixture is continuously formed in the evaporator and the lighter gas is continuously formed in the absorber. We therefore



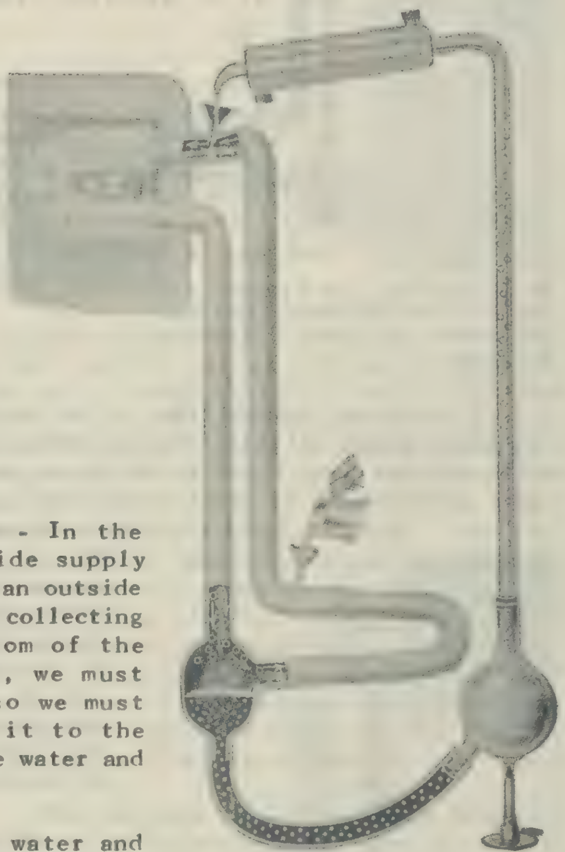
The hydrogen circuit

have continuous circulation, like a water wheel constantly supplied with water flowing down on one side and weighing that side down and flowing away at the bottom so that the other side is lighter.

In our case, the hydrogen gas is the wheel which goes round and round. The alcohol evaporating into the hydrogen weighs down the hydrogen to make one side of the circuit heavy. The other side is lighter because the alcohol is taken away at the bottom (in the absorber). We now have a closed evaporator-absorber circuit continuously producing cold-without the use of a fan, pump, or other machinery.



A laboratory still. Vapor is driven off and condenses in the condenser.

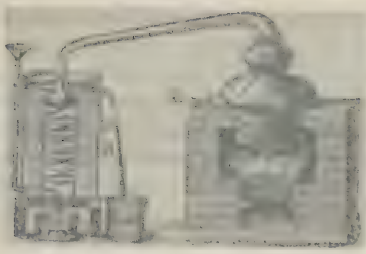


The alcohol is distilled from the solution and is liquefied in the condenser and flows into the evaporator.

WE COMPLETE AND CLOSE THE SYSTEM - In the system so far built up, we have an outside supply of alcohol to the evaporator; we also have an outside supply of water to the absorber; and we are collecting alcohol dissolved in water at the bottom of the absorber. To make the system complete, we must separate the alcohol from the water; also we must lift the separated alcohol and return it to the evaporator as a liquid; and we must lift the water and return it to the absorber.

An easy way to separate alcohol from water and liquefy the alcohol is to use a "still". This permits us to use heat alone and avoid moving parts. A still is a simple structure-a generator for vaporizing the substance to be distilled and a condenser connected to the generator to liquefy the vapor. We can use a very small still heated by a small burner. The alcohol is driven off as a vapor in the generator, leaving the water as a residue. Alcohol has a lower "boiling point" than water. The vapor, as we know, rises in the still and liquefies in the "worm" or condenser, and issues as a pure liquid. So let us connect an ordinary still to the bottom of the absorber to receive the alcohol solution and connect the drip outlet of the still to the evaporator. We see that the evaporator becomes the receiver of the still.

We have now completed the system, except for one thing: We have not raised the water so it can flow back into the absorber.



A dictionary definition of "still": (a) is the worm or condenser, (b) the cooler for the worm, (c) the generator.

In a coffee percolator, steam raises water to the top of the percolator so that it can drip down through the coffee grounds.

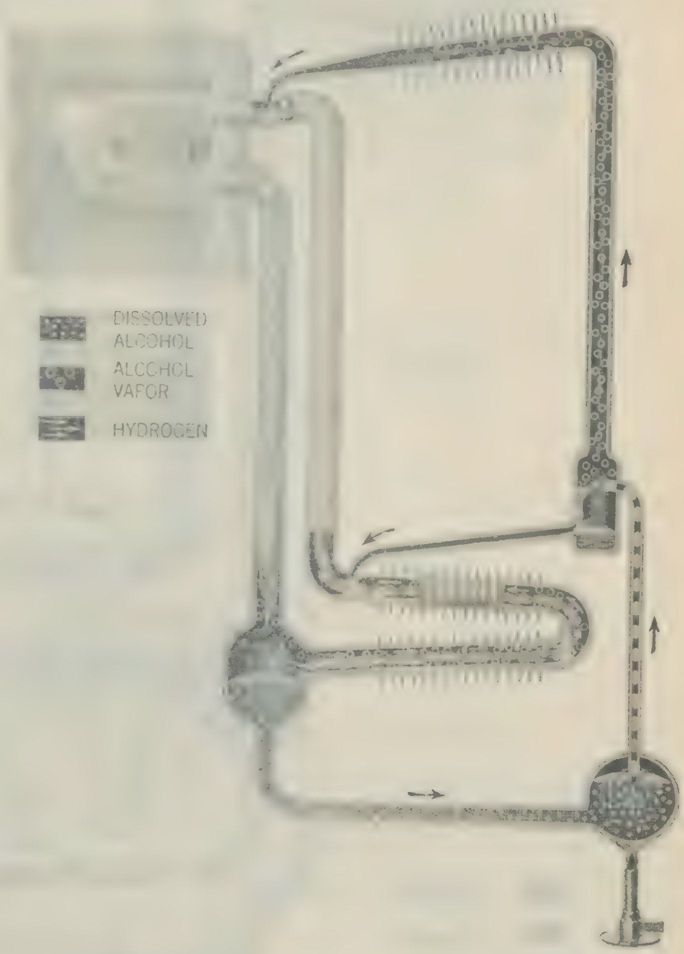
How shal! we lift the water? Of course, we could use a mechanical pump, but that would require moving parts. We do not want moving parts. What is there that lifts liquid without moving parts? We all know that a coffee percolator lifts liquid.

Let us place a percolator lifter in the still. Instead of a perforated pan at the top of the liquid lifter as in a coffee pot, which lets the water flow right back, we will catch the water at a level above the absorber so that it can flow into the absorber by gravity. The alcohol vapor takes the place of steam in the coffee pot. We simply let the vapor pass on to the "worm" or condenser.

We actually do not need water cooling. We can simply put cooling fins on the condenser pipe and let the atmosphere cool it, as the air cools the radiator in our automobile. Due to the "air cooling" the alcohol vapor is liquified.

The absorber will become warm as the alcohol dissolves, so we must cool the absorber as well as the condenser. This part we can also "air cool" in the same way as our condenser by simply putting cooling fins on the absorber pipe.

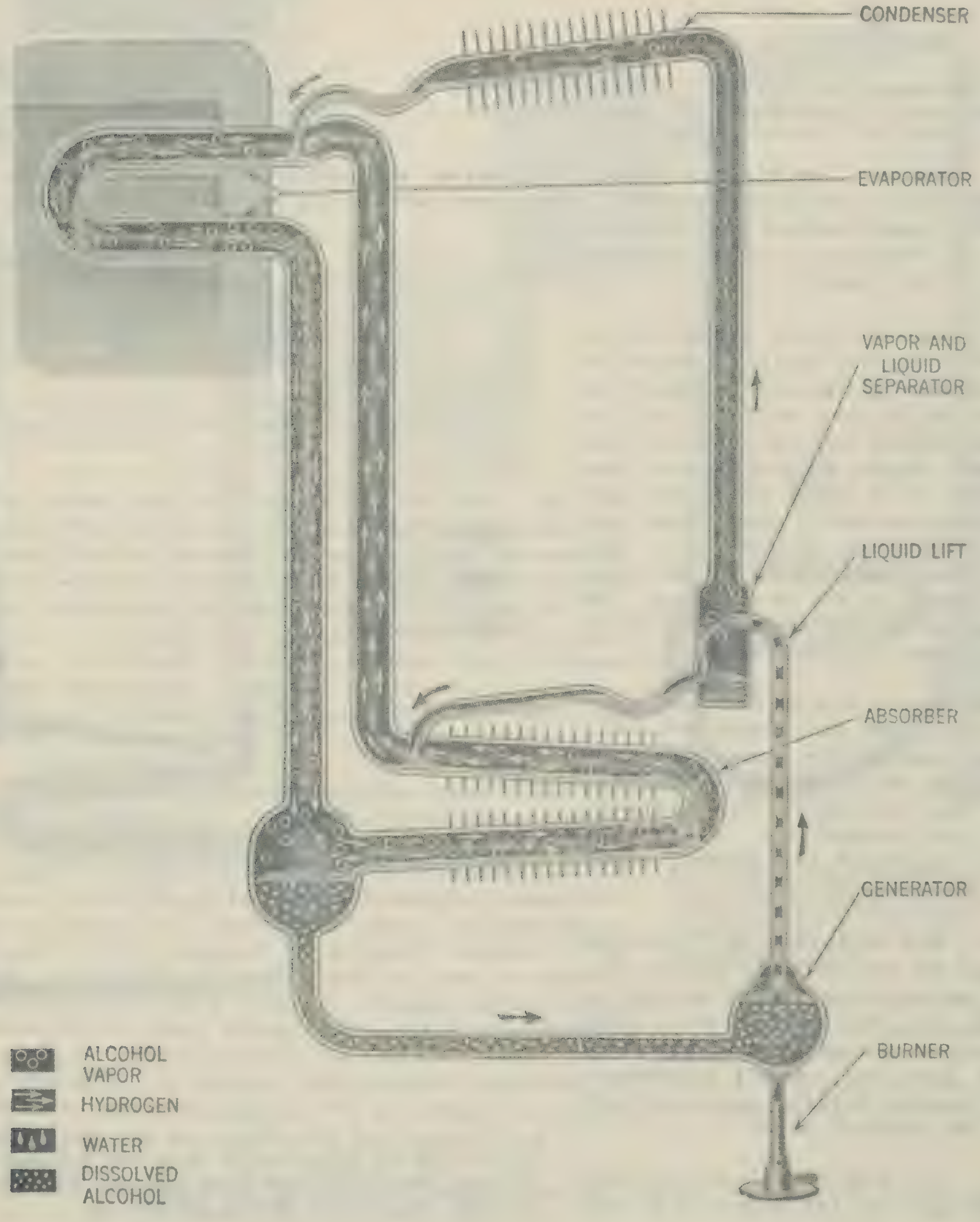
In order to confine the hydrogen to its circuit we can



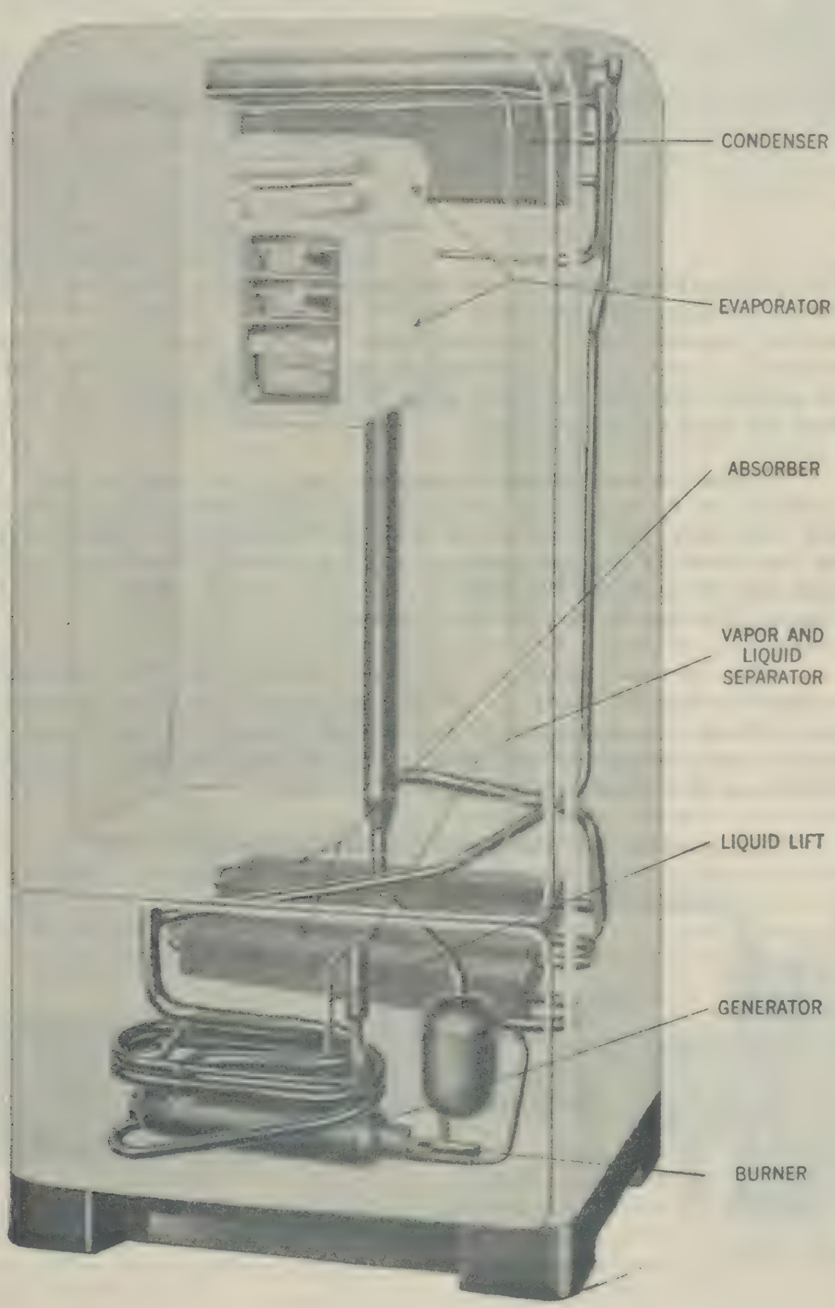
We utilize the principle of the coffee percolator lift to raise water with the alcohol vapor so that the water can flow through the absorber without the use of moving parts.

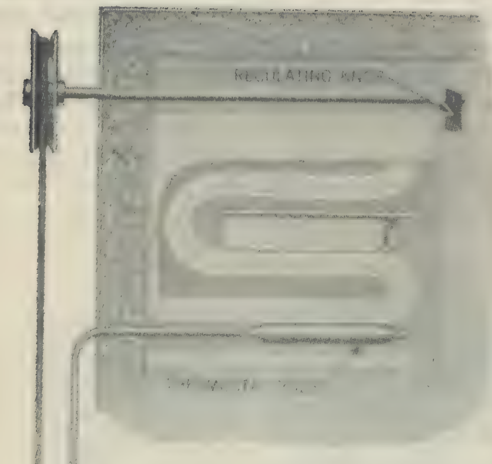
simply bend the pipes carrying liquid to this circuit so as to form liquid traps (see illustration below).

COLD FROM HEAT, IN PRINCIPLE - Here we have the complete refrigerator which we have built up step by step. The parts are shown opened so that we can see the hydrogen flowing in its circuit between the evaporator and the absorber; the water flowing in its circuit between the absorber and the generator; and the evaporative fluid flowing in its circuit through the evaporator, absorber, generator, vapor and liquid separator, and condenser, and back to the evaporator.



PRINCIPLE APPLIED TO PRACTICE - Here we have the refrigerating system as actually built for one model of the Servel Gas refrigerator. Note how the parts correspond. The actual refrigerator includes some additional refinements not included in the system we have built up. Additional refinements are described on later pages. However, the picture on Page 6 shows clearly how cold is obtained from heat without moving parts.





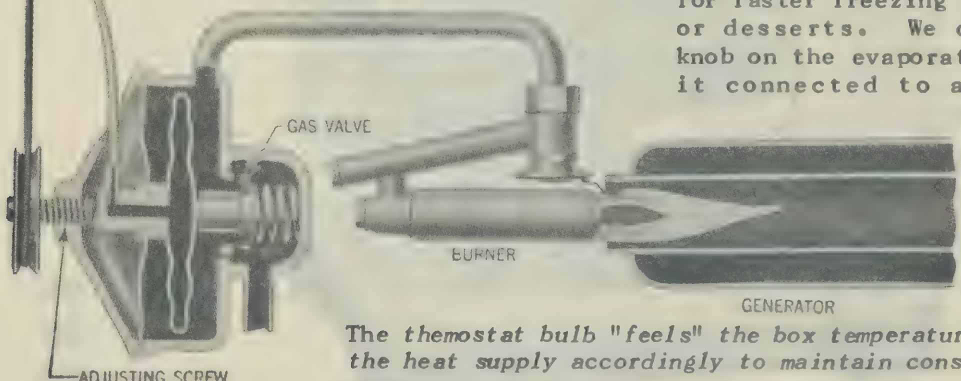
CONTROLLING OUR REFRIGERATOR - We have built a refrigerator in which we apply heat to one part and at the same time produce refrigeration at a remote part. How can we control the amount of refrigeration produced so that the refrigerator box will be neither too warm not too cold? If we analyze the system we have built up we will find that this solves itself.

Suppose we increase the supply of heat. This will drive off more vapor in the generator and consequently more will condense in the condenser. This means that more liquid will flow into the evaporator to evaporate and more intense cold will be produced. Also, since evaporation is increased, the circulation between the evaporator and the absorber will be intensified, because one vertical branch of the hydrogen circuit gets heavier as the evaporation is intensified. We have seen that by increasing the alcohol quantity and "blowing" more on it can we produce more cold. So, by merely varying the heat supply, the whole system can be made to give more or less refrigeration.

Since we are using a gaseous fuel, the regulation is easily accomplished by a simple thermostat. The thermostat bulb is placed in the box near the evaporator and it "feels" the temperature. When it is too warm it causes expansion of a simple diaphragm to give a wider opening of a valve in the gas supply line. When it is too cold, it reduces the gas supply to the burner.

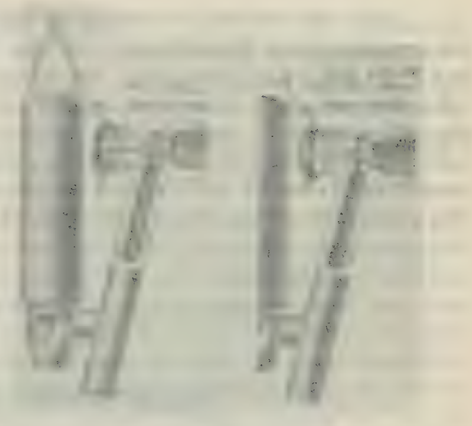
Also we can easily control the burner flame for safety. A shut-off valve in the gas line is connected to a simple fool-proof disc which has a finger extending into the burner flame. If the burner flame should go out, the finger quickly cools and so does the disc, and when it cools, it closes the shut-off valve.

Our system and its simple control also permits easy manual setting for faster freezing of ice cubes or desserts. We can place a knob on the evaporator and have it connected to adjust the

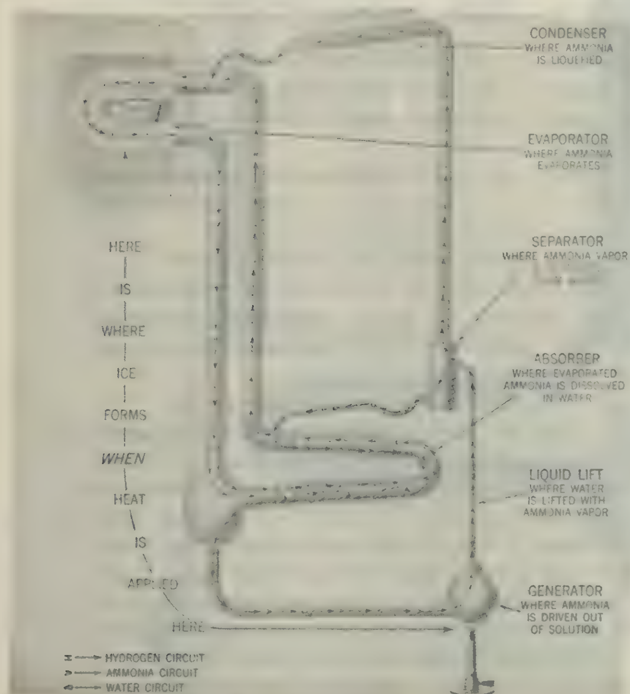


The themostat bulb "feels" the box temperature and varies the heat supply accordingly to maintain constant temperature.

THE TEMPERATURE REGULATOR
A turn of the knob adjusts the thermostat so that a higher or lower evaporator temperature is automatically maintained.



The heat of the flame buckles a disc to one side to hold a valve in the gas line open. If the flame goes out, the disc buckles to the other side, closing the valve.



A picture of the system using ammonia looks just like the picture of the system using alcohol.

thermostat to a higher or lower temperature. This is easily done by an adjusting screw connected to the knob by a simple pulley.

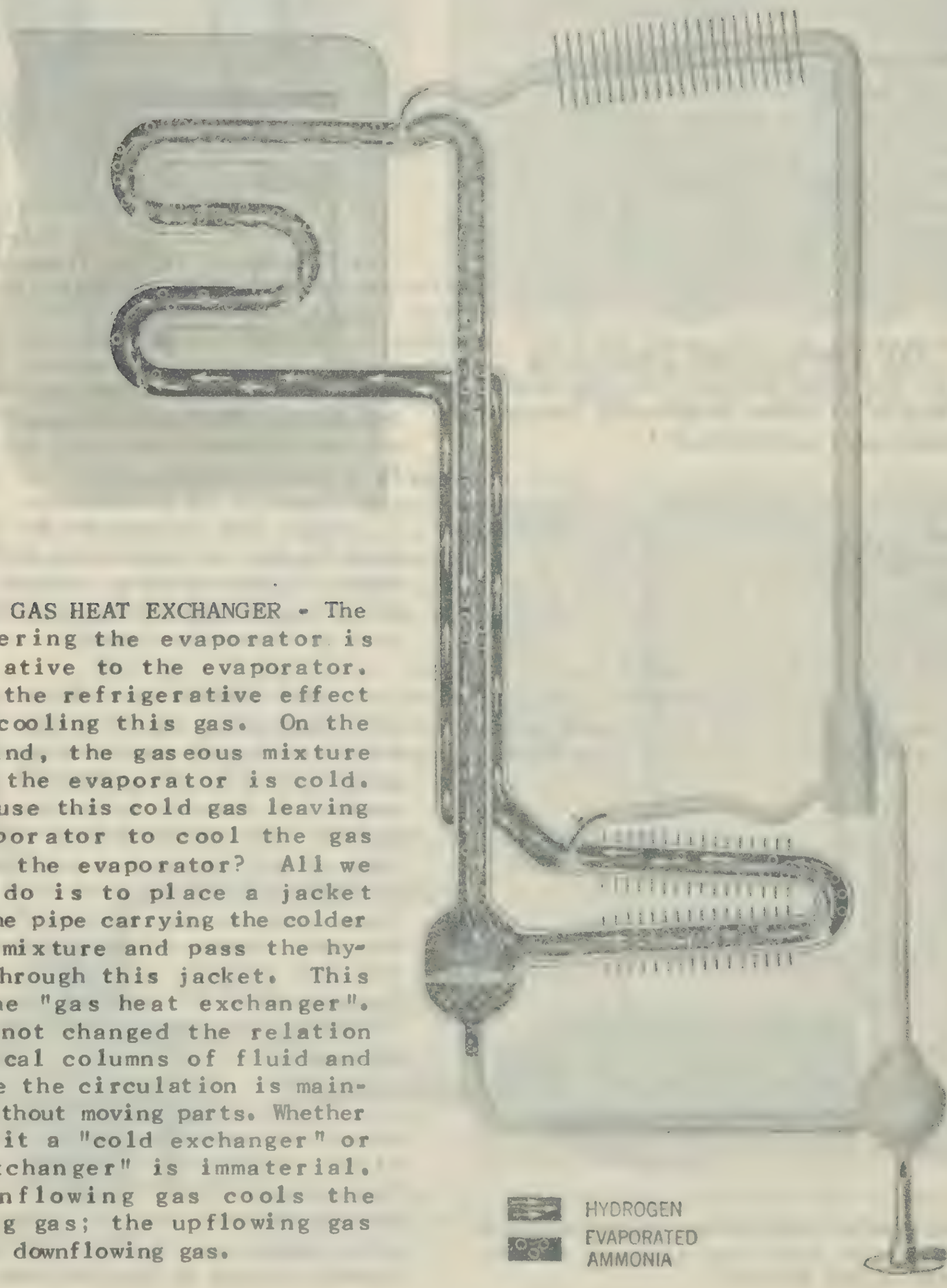
Gas has proved to be an ideal fuel for this refrigerating system, because of its economy, safety, availability, freedom from attention and ease of automatic control.

WHY AMMONIA? - When we first produced cold by blowing into our evaporator, we used alcohol as the evaporating fluid. Alcohol could be used, but ammonia is better. It requires less ammonia than alcohol to take up and transmit a certain amount of heat. Since we need to circulate less ammonia than alcohol to obtain the same amount of refrigeration, we are able to build a smaller unit if we use ammonia. Of course, compactness is very important in a household refrigerator.

The system will work the same way when using ammonia, but it requires a higher pressure to condense ammonia. This is accomplished by introducing the fluids into the unit under a suitable pressure before the unit is finally sealed in the factory.

WE ADD SOME REFINEMENTS

COUNTER-FLOW IN THE EVAPORATOR - As we first built the evaporator, both the evaporative liquid and the gas flowed downwards. When we built the absorber, we had the gas pass upwardly "counter-flow" to the liquid for more efficient contact. Likewise we will have better efficiency if we have the hydrogen gas pass upwardly in the evaporator. And we can simply reverse the connections to do this without disturbing the natural circulation between the absorber and the evaporator because the absorber is well below the evaporator so that a heavier gas column must form in the pipe now connecting the top of the evaporator with the bottom of the absorber.



THE GAS HEAT EXCHANGER - The gas entering the evaporator is warm relative to the evaporator. Some of the refrigerative effect goes to cooling this gas. On the other hand, the gaseous mixture leaving the evaporator is cold. Why not use this cold gas leaving the evaporator to cool the gas entering the evaporator? All we need to do is to place a jacket around the pipe carrying the colder gaseous mixture and pass the hydrogen through this jacket. This makes the "gas heat exchanger". We have not changed the relation of vertical columns of fluid and therefore the circulation is maintained without moving parts. Whether we call it a "cold exchanger" or "heat exchanger" is immaterial. The downflowing gas cools the upflowing gas; the upflowing gas heats the downflowing gas.

A reserve of hydrogen to be pushed into the circuit when outside temperature is high.

THE HYDROGEN RESERVE VESSEL - Our system is "air cooled". It is air cooled by atmospheric air. The temperature of the atmosphere is high in summer and low in winter. Consequently we have a higher condenser temperature in the summer than in the winter.

In a condenser containing only ammonia, there is a relation between pressure and temperature. As the outside temperature varies, so the temperature inside the condenser varies and the pressure goes up and down with the temperature. There is a relation between pressure and temperature in a fluid changing from liquid to vapor (and vice versa). A familiar illustration of this is the decrease in temperature at which water boils as we go up a mountain because of the decrease of atmospheric pressure. If the pressure in the condenser is too low in relation to the temperature, the ammonia will not condense.

In our system as we have built it up so far, the pressure must be high enough so that we will have condensation of ammonia in the ammonia condenser at the highest air temperature of the summer time. We can easily charge the system to a accomplish this by adding enough hydrogen. But in that case we would be operating at a higher pressure during most of the year when we could very well do with much less pressure. We would prefer to have a lower pressure as much of the time as possible because it is easier to drive the ammonia out of solution at lower pressure, and this in turn results in lower operating cost.

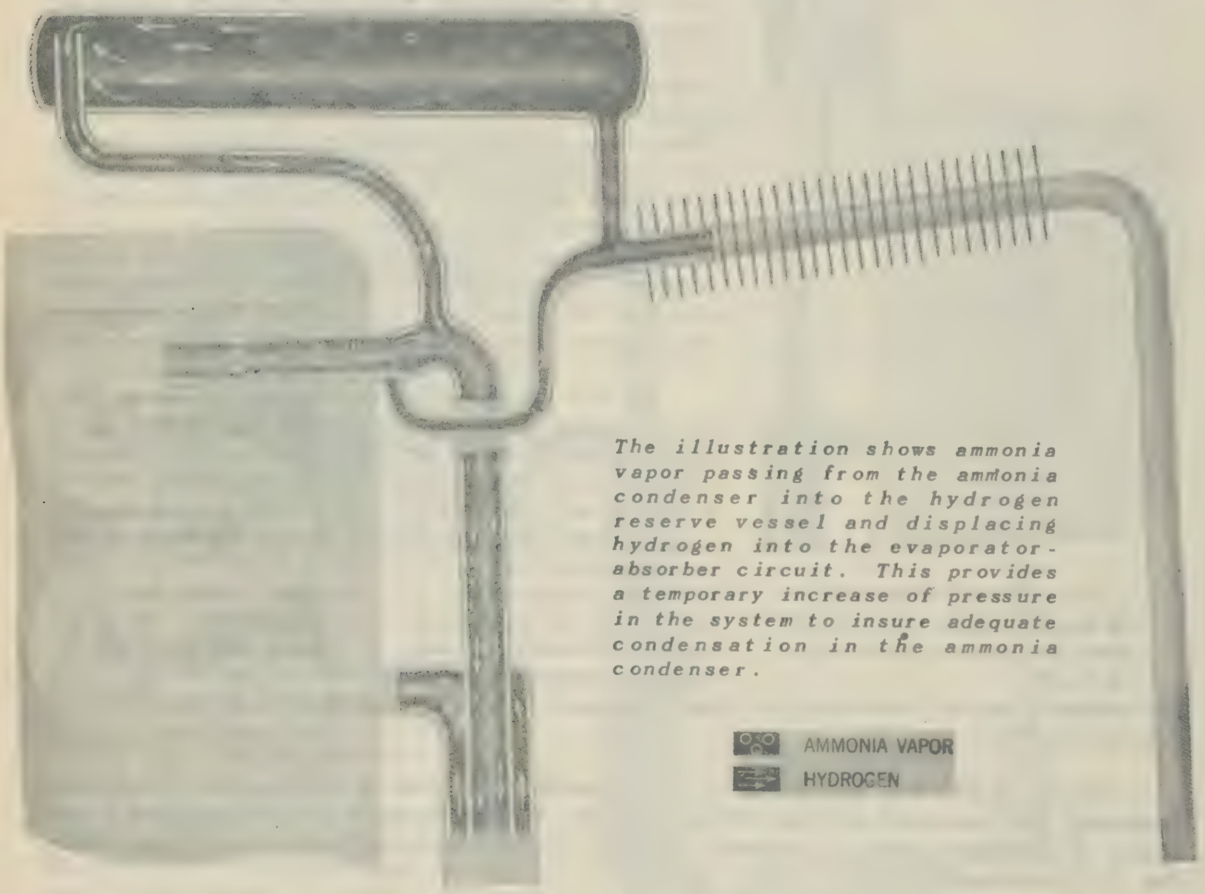
Can we build the system so that we ordinarily have a low pressure and only increase the pressure on the hottest days? We can do this if we can have a reserve of hydrogen which is pushed into the evaporator-absorber circuit only when the air abnormally high.

So we make a reserve vessel for hydrogen and connect it to the system. Normally the hydrogen stays in this reserve vessel and we can operate normally at lower pressure. If the air temperature rises so high that the pressure is inadequate for condensation in the ammonia condenser, we simply push more hydrogen into the active part of the system from our reserve vessel. To push this hydrogen into the circuit we could use a pump or a piston. But we would like to accomplish this also without moving parts and automatically. Fortunately we have factors in our system which can be applied to accomplish this. We can push the hydrogen into the active part of the system by the ammonia which does not condense.

Therefore in place of using a pump or piston we simply connect our reserve vessel to the outlet of the ammonia condenser. If the ammonia vapor cannot condense, it must pass through our new pipe to the reserve vessel. This displaces the hydrogen out into the active part of the system. The ammonia vapor now in the reserve vessel corresponds to a quantity of ammonia (by weight) which was previsously in solution and therefore occupied only a fraction of the space it now occupies in the reserve vessel. The hydrogen is still a gas. Due to the greater

proportion of gaseous to liquid ammonia in the system the pressure is higher, which permits adequate condensation in the ammonia condenser.

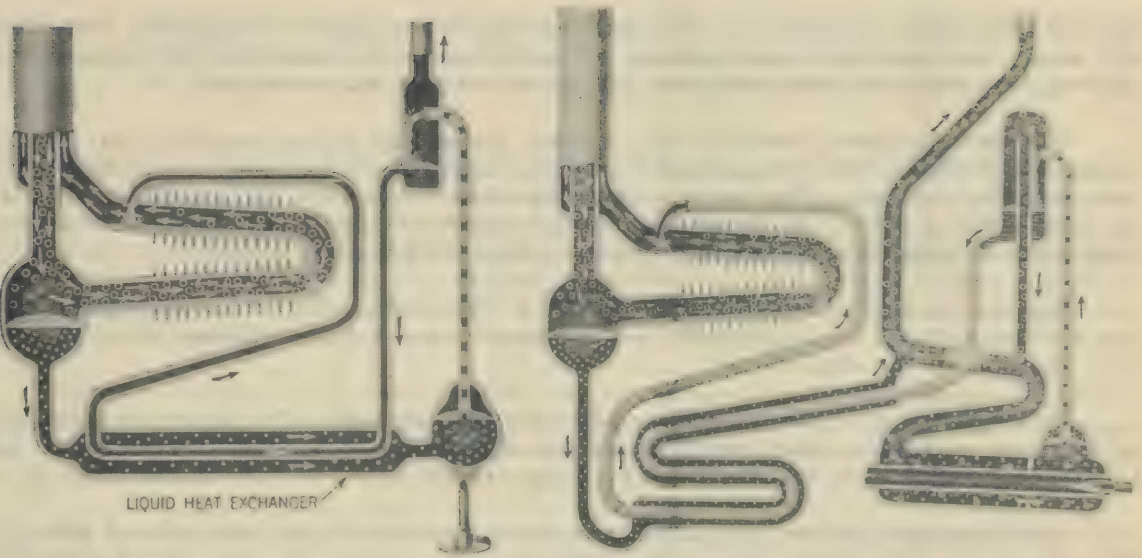
When the outside temperature becomes normal again, the condenser action is intensified and the ammonia is drawn back into the active part of the system from the reserve vessel; and hydrogen is drawn back into the reserve vessel.



The illustration shows ammonia vapor passing from the ammonia condenser into the hydrogen reserve vessel and displacing hydrogen into the evaporator-absorber circuit. This provides a temporary increase of pressure in the system to insure adequate condensation in the ammonia condenser.

THE LIQUID HEAT EXCHANGER AND THREE STAGE AMMONIA DISTILLATION - The solution flowing to the generator is cool. The liquid flowing to the absorber is warm. We can save gas if we use the warm liquid to heat the cooler liquid. To do this, we simply run the water pipe downwardly from the "separator" and inside the pipe carrying the solution to the generator. Of course we then must run this pipe up again to connect with the upper part of the absorber. We have made a simple "liquid heat exchanger". The warm liquid "preheats" the colder solution flowing to the generator. The cool solution "precools" the liquid flowing to the absorber.

We can make a further saving if we distill off the ammonia in stages of increasing temperature. To do this, we first "bubble" the ammonia vapor through the solution flowing to the generator. This can be done by running the ammonia vapor pipe from the separator down to connect with the pipe in which the solution flows to the generator. This forms a "submersion analyzer" in which water vapor is



removed from the ammonia flowing to the condenser. From the analyzer, the solution flows through a second generator chamber before it flows to the final and hottest generator chamber.

A MORE TECHNICAL DESCRIPTION - STARTING AT THE GENERATOR
(See Diagram Following)

The freezing system of the Servel Gas Refrigerator is made up of a number of steel vessels and pipes welded together to form a hermetically sealed system. All the spaces of the system are in open and unrestricted communication so that all parts are at the same total pressure.

The charge includes an aqua-ammonia solution of a strength of about 30% concentration (ammonia by weight) and hydrogen. For a unit of sufficient capacity for a 5 cu. ft. cabinet, the approximate charge is: 1.1 lbs. ammonia; 2.6 lbs. water; 0.03 lb. hydrogen. The liquid is charged into the unit as solution and then the hydrogen is added.

The elements of the system include a *generator* (1) (sometimes called *boiler or still*), a *condenser* (2), an *evaporator* (3), an *absorber* (4), and a *hydrogen reserve vessel* (5). There are three distinct fluid circuits in the system: An ammonia circuit including the generator, condenser, evaporator, and absorber; a hydrogen circuit including the evaporator and absorber; and a solution circuit including the generator and absorber.

Starting with the generator, heat is applied by a gas burner or other source of heat to expel ammonia from solution. The ammonia vapor thus generated flows to the condenser. In the path of flow of ammonia from the generator to the condenser are interposed an *analyzer* (6) and a *rectifier* (7). Some water vapor will be carried along with the ammonia vapor from the generator. The analyzer and rectifier serve to remove this water vapor from the ammonia vapor. In the analyzer, the ammonia passes through strong solution which is on its way from the absorber to the generator. This reduces the temperature of the generated vapor somewhat to condense water vapor and the resulting heating of the strong solution expels some ammonia vapor

without additional heat input. The ammonia vapor then passes through the rectifier (7) where the residual small amount of water vapor is condensed by atmospheric cooling and drains to the generator (1) by way of the analyzer (6).

The ammonia vapor, which is still warm, passes on to the section (2a) of the condenser (2) where it is liquefied by air cooling. The condenser is provided with fins for this purpose. The ammonia thus liquefied flows into the evaporator (3) at an intermediate point. A liquid trap is interposed between the condenser section (2a) and the evaporator to prevent hydrogen from entering the condenser.

Ammonia vapor which does not condense in the condenser section (2a) passes to the section (2b) of the condenser and is liquefied and flows through another trap into the top of the evaporator.

The evaporator is made up of two sections (3a) and (3b). The upper section (3a) is provided with fins and directly cools the food space. The lower section (3b) is in direct contact with the ice freezing compartment.

Hydrogen gas enters the lower evaporator section (3b) and, after passing through a precooling pipe part, flows upwardly, in counter-flow to the downwardly flowing liquid ammonia. The effect of the placing of a hydrogen atmosphere above the liquid ammonia in the evaporator is to reduce the partial pressure of the ammonia vapor in accordance with Dalton's law of partial pressures. While the total or gage pressure in the evaporator and the pressure in the condenser are the same, there is substantially pure ammonia in the space where condensation is taking place and consequently the vapor pressure of the ammonia substantially equals the total pressure. Under Dalton's law, the total pressure of a gas mixture is equal to the sum of the partial pressures of the individual gases. Consequently in the evaporator the partial ammonia vapor pressure is less than the total pressure by the value of partial pressure of the hydrogen. The lesser ammonia vapor pressure results in evaporation of the ammonia with consequent absorption of heat from the surroundings of the evaporator and the cooling of the surroundings which are in a well-insulated enclosure.

The cool heavy gas mixture of hydrogen and ammonia vapor formed in the evaporator leaves the top of the evaporator and passes downwardly through the center of the *gas heat exchanger* (8) to the absorber (4). In the absorber, ammonia is absorbed by water, and the hydrogen, which is practically insoluble, passes upwardly from the top of the absorber through the external chamber of the gas heat exchanger (8) into the evaporator. Perfect separation of gases is of course not possible and some ammonia vapor passes with the hydrogen from the absorber to the evaporator. It is probably more accurate to call the gas flowing from the evaporator to the absorber *strong gas* (hydrogen strong in ammonia) and call the gas flowing from the absorber to the evaporator *weak gas* (hydrogen weak in ammonia).

Since the weight of a gas is proportional to its molecular weight and the molecular weight of ammonia is 17 and the molecular weight of hydrogen is 2, it follows that the specific weight of the strong gas is greater than that of the weak gas. This difference in specific weights is alone sufficient to inititate and maintain circulation between the evaporator and the absorber. Since the absorber is below the evaporator, it is possible to have upward gas flow in the evaporator. The long vertical column of strong gas in the central chamber of the gas heat exchanger is heavier than the vertical column in the absorber, external heat exchanger space and evaporator, despite the fact that the gas in the evaporator is heavy. Consequently the gas will flow as above stated due to the difference in specific weights of the gases in the different vertical branches of the circuit. The gas heat

exchanger transfers heat from the weak gas to the strong gas. This saves some cooling in the evaporator by precooling the entering gas. A liquid drain at the bottom of the evaporator is connected to the downflow space of the gas heat exchanger.

Counter-current flow in the evaporator permits the location of the box cooling section of the evaporator in the most effective position, at the very top of the food space. Also, the gas leaving the lower temperature evaporator section (3b) can pick up more ammonia at the higher temperature prevailing in the box cooling evaporator section (3a), thereby increasing capacity and efficiency. There is still another advantage in that liquid ammonia flowing to the lower temperature evaporator section is precooled in the upper evaporator section.

The dual liquid connection between the condenser and the evaporator is advantageous in applying the unit to the cabinet. It permits extending the condenser below the top of the evaporator to provide more surface while having gravity flow of liquid ammonia to the evaporator.

The two-temperature evaporator partially segregates the ice freezing function from the box cooling function. This provides a better humidity condition in the food space because, due to the higher temperature of the box cooling section (though adequately low for proper preservation), and due to the reduced surface of the low temperature section permitted by the partial segregation of function, less moisture is extracted to form frost.

In the absorber, a flow of weak solution (water weak in ammonia) comes in direct contact with the strong gas. The liquid and gas flow in counter-current. The weak solution is thus enriched or stregthened while the strong gas is weakened.

From the absorber, the strong solution flows through the *liquid heat exchanger* (9) to the analyzer (6) and thence to the strong liquid chamber (1a) of the generator (1). Heat applied to this chamber causes vapor to pass upwardly through analyzer (6) and to the condenser. The solution passes through an aperture in the generator partition into the weak liquid chamber (1b). Heat applied to this chamber causes vapor and liquid to pass upwardly through the small diameter pipe (10), as in an "air lift", to the separation vessel (11). Liberated ammonia vapor passes through the analyzer (6) and thence to the condenser. The weak solution flows through the liquid heat exchanger (9) and to the absorber. The liquid heat exchanger precools the liquid entering the absorber and preheats the liquid entering the generator. Further precooling of the weak solution is obtained in the finned air cooled loop (12) between the liquid heat exchanger and the absorber.

The heat which is liberated by absorption of ammonia in the absorber is carried away by air flowing in contact with the absorber fins.

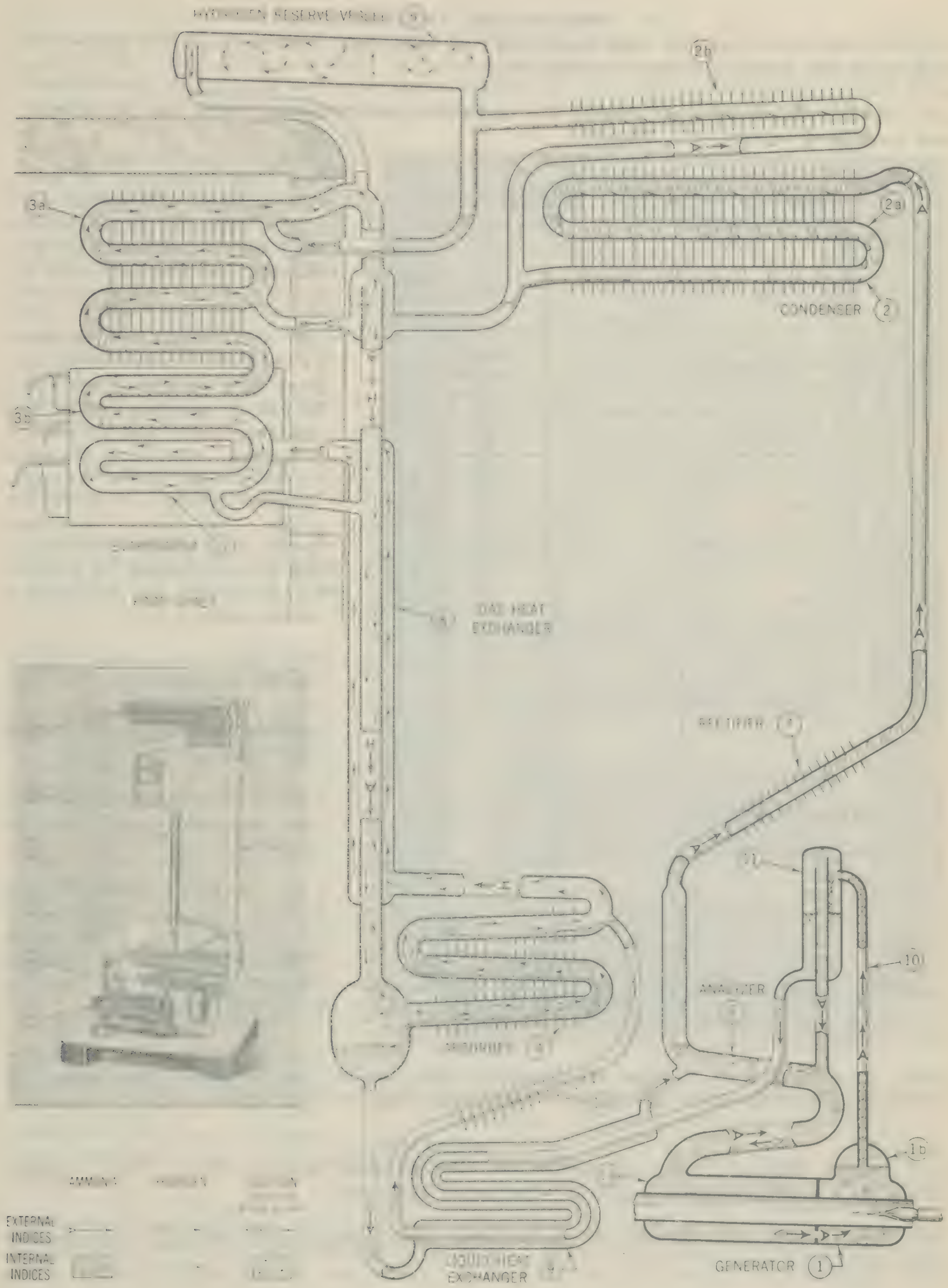
The hydrogen reserve vessel (5) which is connected between the condenser outlet and the hydrogen circuit may be described as a reservoir for hydrogen gas while the refrigerator is operating under normal room temperature conditions. Under these conditions an appreciable part of the hydrogen in the system is stored in the reserve vessel. The remainder is located in the evaporator-absorber circuit and serves to balance the condenser pressure. This pressure must of course be adequate to liquefy the ammonia gas in the condenser. If the pressure is increased, the effeciency under normal conditions will be impaired, and yet it is necessary to have a higher pressure in the system to insure condensation of the ammonia under high room temperature conditions. The reserve vessel and its connection in the system is an automatic pressure variant to take care of the variable room temperature and

loads and to permit lower operating pressure at lower room temperature, thereby resulting in better efficiency and higher operating pressure under extreme conditions to insure condensation of ammonia. It operates in the following manner:

Should the room temperature rise materially, ammonia vapor fails to condense in adequate quantity and some vapor flows to the hydrogen reserve vessel. Thus additional ammonia vapor is liberated by the generator and is pushed through the condenser and into the reserve vessel, displacing the hydrogen therein, which is in turn pushed into the active part of the system. This displacement of hydrogen by ammonia and the redistribution of hydrogen has a double effect. The pressure in the system is increased due to the additional ammonia gas present. This results in and adequate condensing pressure at the higher room temperature. At the same time the additional hydrogen in the evaporator serves to balance the increased condenser pressure without increasing the partial pressure of ammonia in the evaporator. Without this additional hydrogen it would be necessary to balance the increased pressure by raising the ammonia pressure in the evaporator which would result in an undesirable increase in evaporator temperature. When the room temperature decreases again, the more effective condensation in the condenser causes the ammonia gas to return from the reserve vessel to the ammonia condenser and hydrogen (weak gas) flows from the evaporator-absorber circuit into the reserve vessel.

As refrigeration load increases, a thermostat functions to increase the flow of gas to the burner which causes a greater amount of ammonia to be expelled, condensed, and evaporated per unit of time.

The actual construction includes additional refinements which increase efficiency.


2b
3a
2a
CONDENSER 2
3b
GAS HEAT EXCHANGER
RECTIFIER
11
10
ANALYZER
1b
EXTERNAL INDICES
INTERNAL INDICES
LIQUID HEAT EXCHANGER
GENERATOR 1

MODELS N-603 AND N-803

1. PRELIMINARY INSTRUCTIONS

(a) In the first part of this text, are the important instructions for installing and using the Servel kerosene refrigerator.

(b) Fuller explanation of some of the operating instructions, which may be helpful, are contained in Par. 17, "Notes".

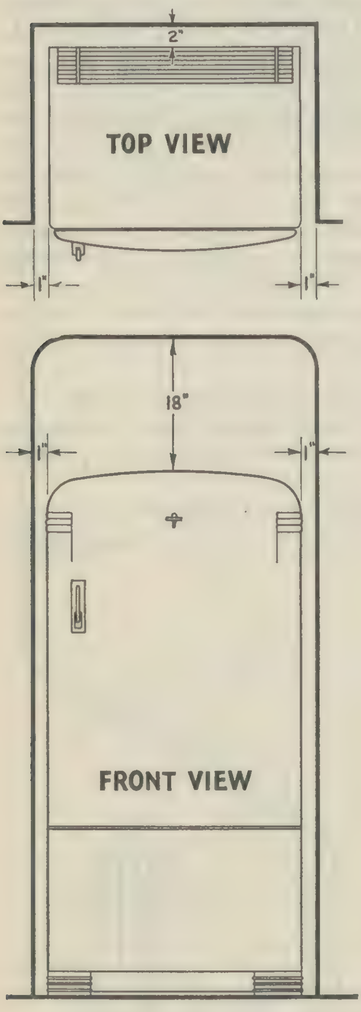


Fig. 1. Fully Recessed.

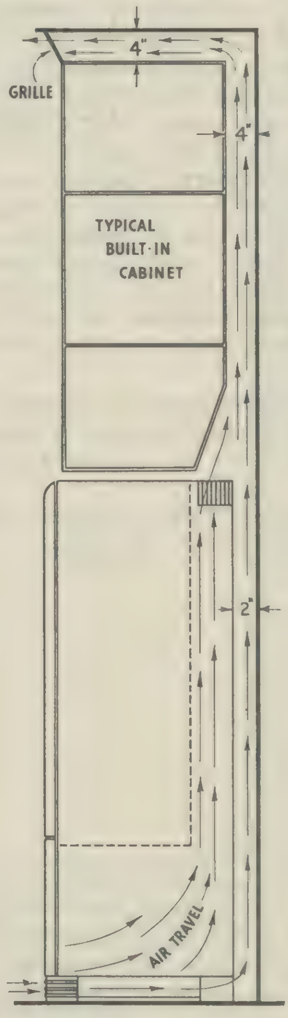


Fig. 2. Ventilating Duct.

(c) The last part of this text contains instructions which need be referred to only when maintenance is required. On the last page is "Operation Analysis".

(d) After the refrigerator is uncrated, carefully unpack the accessories contained in cartons within the refrigerator. The accessories are: shelves, storage trays, ice cube trays, dessert trays, ice cube grids, tray lever, kerosene funnel (filter in position). The glass chimney is packed separately in freezing compartment.

(e) The accessories should not be installed in the refrigerator until after it has been placed in operating location.

(f) Open burner compartment door and remove cord tied to burner.

(g) Remove metal band holding kerosene tank in position. Pull the tank forward and remove packing beneath same. Push tank to original position.

(h) In moving the refrigerator, be careful not to bend the kerosene tank pan at the bottom of the tank. If bent, it should be straightened, or the chimney may not seal (Par. 7-g).

2. LOCATION

(a) To get the best results, locate the refrigerator indoors, where its refrigerating unit will always be *properly ventilated* and *level*.

(b) The refrigerator should not be located where continually exposed to excessive heat or cold.

3. VENTILATION

(a) The cooling of the finned section of the refrigerating unit, located beneath and at the rear of the cabinet, is automatic, while the refrigerator operates. The ventilating air enters the open space around the base of the refrigerator and flows upward through the finned section and out at the top grille of the cabinet.

(b) If natural air curculation is retarded by lack of clearance, cross and down drafts, or blocked by obstacles, the refrigerator will not work properly.

(c) Proper ventilation will usually result when the refrigerator is installed in front of a solid wall, allowing at least the following clearances:

Between back of refrigerator and the wall--2".

Between top of refrigerator and overhanging ceilings, shelves, or cabinets:

OVERHANG	CLEARANCE
All way to front of cabinet	----- 18"
Half way to front of cabinet	----- 12"
Quarter way to front of cabinet	----- 9"

(d) A fully recessed refrigerator installation is illustrated in Fig. 1.

(e) When the required top ventilating clearances cannot be had, a ventilating duct should be installed as illustrated in Fig. 2.

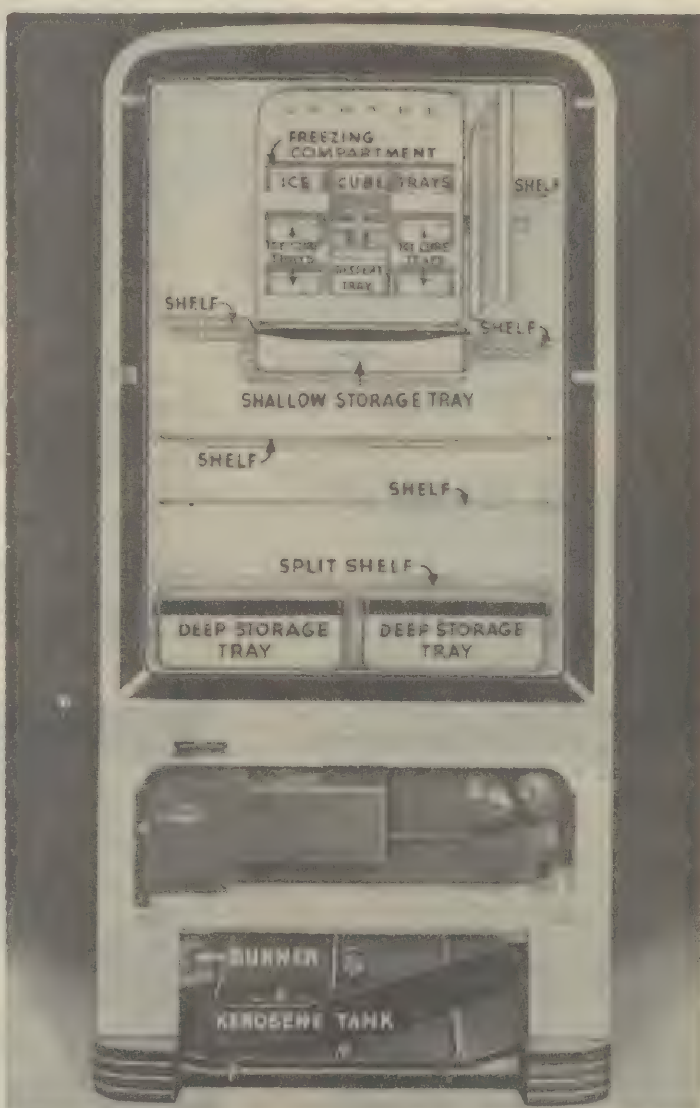


Fig. 3. Refrigerator Model N-803, showing interior accessories; also kerosene tank and burner.

4. LEVELING

(a) The gravity flow of the fluids within the refrigerating unit requires the unit to be installed and maintained in a level position, both front to back and side to side.

(b) Check the level of the refrigerating unit by placing an ice cube tray, partly filled with water, on the dessert tray shelf. When level, the surface of the water will parallel the top of the tray. (Use a 3" spirit level, if available, in

preference to tray and water method. Level on dessert tray shelf, front to back and side to side.)

(c) Use solid shims under the refrigerator legs to keep refrigerator level. Strengthen weak floors to prevent their sagging.

(d) After leveling, install accessories in food compartment (Fig. 3).

5. CHOICE OF KEROSENE (COAL OIL)

(a) Use kerosene only. Never mix with it gasoline or other fuels.

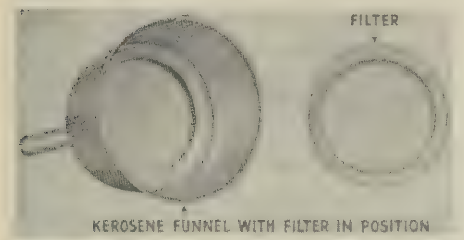


Fig. 4. Kerosene Funnel and Filter.

(b) Some kerosenes are better than others for use in the Servel burner. The desirable kerosenes will not form carbon as quickly or form as hard carbon on the wick, as less desirable brands. The carbon forming characteristics of kerosene can be determined only from experience.

(c) The kerosene chosen should be clean and kept clean. It is easy for dirt and water to get into kerosene if not properly handled and stored. Before filling a can, make sure that it is clean and always keep the storage can tightly covered.

6. FILLING THE TANK

(a) Always use the Servel kerosene funnel with filter in position when filling the tank, as the filter will help to remove any dirt and water which may get in the kerosene (Fig. 4).

(b) The filter should be removed from the funnel occasionally and cleaned by washing in kerosene.

(c) Place funnel in filling position (Fig. 5).

(d) Fill tank with kerosene. The tank holds 4½ gallons and it should be filled carefully when the tank gauge pointer approaches the "F" (full) mark, to avoid overfilling the tank (Fig. 6).

(e) Clean off any kerosene on top of tank. If kerosene overflows the tank and spills on the tank pan, the kerosene should be cleaned off the pan after removing tank (Par. 24).

Refrigerator Model N-603 Refrigerator Model N-803

Fig. 5. Funnel in position for filling tank.

(f) Do not let the tank run dry while the refrigerator is in use because refrigeration will be interrupted and a portion of the wick will be burned off, reducing wick life.

Fig. 6. Kerosene Tank.

(g) When the tank runs dry, the burner will stay lighted for a while before going out. During this time, the wick fabric burns or chars, and it may be necessary to clean the wick as described in Par. 23-f.

(h) When refilling the tank, the burner flame should be out, as a safety precaution.

5. BURNER OPERATION

(a) Before lighting a new wick for the first time, allow at least one hour for the wick to become soaked with kerosene.

(b) Pull the tank slowly forward as far as possible. (Before moving tank while the burner is in use, unseal glass chimney by pushing seal lever backward as far as possible, Fig. 7.)

(c) Remove burner top, after turning it to the left to unlock. (When removing burner top after the burner has been in use, for convenience, leave glass chimney and chimney support and seal lever in position.)

Fig. 7. Chimney Seal Lever back; chimney unsealed.

(d) Turn wick turner so that the wick height is about 1/8" above top of wick guide (Fig. 8). This will give the proper flame to heat the burner and flues before final flame adjustment.

(e) Light the wick. When the flame is burning all around the wick, replace burner top, chimney support and seal lever, and chimney in unsealed position (Fig. 7). Turn burner top to the right until locked securely in position.

(f) Push the tank back as far as it will go.

(g) Move chimney seal lever forward as far as possible to seal glass chimney (Fig. 10).

(h) At the 1/8" wick height setting, the top of the flame should now be about even with the top of the tube cap.

Fig. 8. Proper wick height for lighting.

(i) Before making final flame adjustment, wait 30 minutes for the burner and flues to become heated, when starting the refrigerator for the first time or when starting after defrosting. Wait proportionately less time for other shorter burner interruptions.

(j) To make the refrigerator most cold: gradually turn the wick up as far as possible without getting yellow tips on the blue flame or a humming noise.

(k) To make the refrigerator less cold: turn the wick down. At very low wick settings, the flame may give kerosene odors.

(l) After using burner avoid damage by not forcing wick turner, if it will not turn. The wick may need replacing or the burner may need cleaning.

(m) To put out the flame: turn wick down, unseal chimney, pull tank forward, and blow out flame.

(n) If the freezing compartment does not start to get cold after two hours burner operation, it is likely that the flame was adjusted too high during the preliminary heating period. In such a case, put out the flame, allow unit to cool to room temperature and start again with a lower flame.

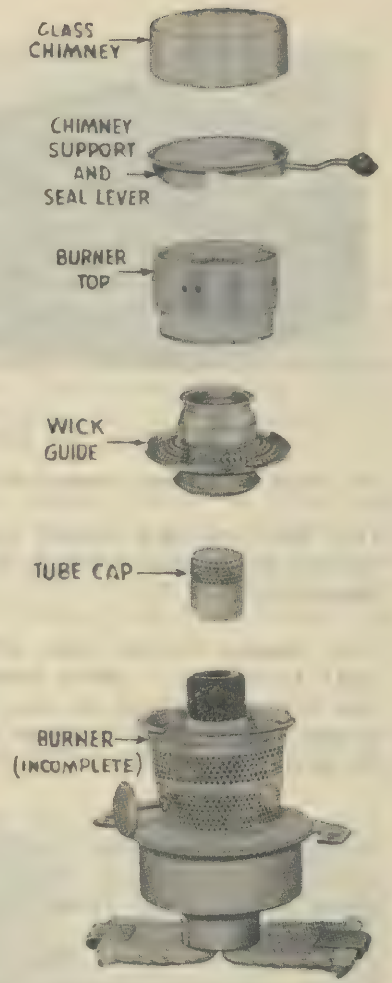


Fig. 9. Burner Parts.

8. FOOD STORAGE COMPARTMENT

(See Par. 13, Storing Foods)

(a) The Servel refrigerator provides several degrees of cold and moisture (Fig. 11). Food should be stored so that it will get the right degree of cold and moisture (Par. 13).

(b) Unless the air within the food storage compartment circulates freely, foods will not be properly cooled. Therefore, don't cut down air circulation by: covering shelves with paper or oil cloth, crowding foods, storing large packages of food, placing foods on top of freezing compartment and storing bottles on their sides.

(c) When a new supply of food is placed in the refrigerator, or when ice cube trays are refilled with water, the refrigerator has to work harder until the additional foods are made cold, or until the added water is frozen. High room temperature also increases the effort of the refrigerator to keep a cold interior. We add to the work or load of the refrigerator when its door is left open, as cold air spills out and is replaced by the warmer air of the room.

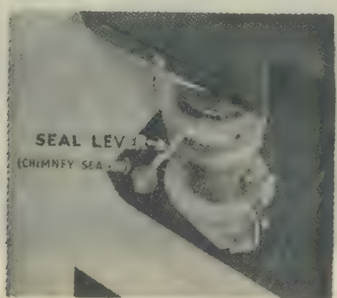


Fig. 10. Chimney Seal Lever forward; chimney sealed.

9. ICE CUBES

(a) Fill ice cube trays with water to about 1/8" below top of ice cube grid to allow for the expansion of water when frozen.

(b) To remove frozen ice cubes, first loosen the tray from the shelf. To do so with trays having a trigger, lift trigger as illustrated in Fig. 12. With trays having a recess at the bottom of the front, use tray lever in recess, (Fig. 13). Loosen grid from tray and cubes from grid by immersing in water.

Fig. 11. Food Compartment Cold Map, Refrigerator Model N-803.

10. DEFROSTING

(a) Frost will form in and on the freezing compartment while the refrigerator is in operation. Frost is frozen moisture which evaporates from uncovered liquids and moist foods while stored in the refrigerator. Moisture is also carried into the refrigerator from the room atmosphere when the door is open. To reduce frost formation, cover stored liquids and moist foods and do not leave the door open longer than necessary.

(b) Frost should be completely removed at least once a week (while cleaning wick and burner), as it retards refrigeration and often makes tray removal difficult.

(c) Any automatic refrigerator has less work to do at night. Take advantage of this by defrosting in the late afternoon or early evening so that the refrigerator can be started again before going to bed.

(d) To defrost, put out the flame and leave it out until defrosting is completed (Par. 7-m). During defrosting, leave the shallow storage tray empty and uncovered, beneath the freezing compartment to catch frost water.

11. CLEANING WICK AND BURNER

(a) While the burner flame is burning, using any suitable grade of kerosene, carbon forms on the top of the wick, on the flange of the wick guide and on the surface of the tube cap. For the best refrigeration results this carbon must be cleaned off at least once a week (while defrosting).

(b) In order to clean the wick and burner, put out the flame and allow a few minutes for the burner parts to cool off. Remove burner top, chimney support and seal lever, glass chimney and tube cap. Turn wick up so that unburned portion of wick is visible.

(c) Clean the carbon from wick using thumb and forefinger with a pinching action, drawing the fingers upward from the wick and slightly shaping the wick top inward (Fig. 14).

(d) After cleaning carbon from the wick, turn wick down so

Fig. 12.

Fig. 13.

that its inner top edge is flush with top edge of burner tube (Fig. 20-B) and smooth the top edge of the wick inward toward the burner tube with the first finger (Fig. 15).

Fig. 14. Cleaning Wick.

Fig. 15. Smoothing Wick.

(e) The top surface of a properly cleaned wick should be free from carbon and frayed fabric threads. It should slope upward to its inner top edge, which should be fairly even. If the top edge of a wick is so uneven that it causes a very irregular flame with yellow tips, the wick should be charred (Par. 23).

(f) Turn the wick down so that its top inner edge is below the top of the burner tube (Fig. 20-B). Scrape the carbon from the top flange of the wick guide and from the tube cap, clearing all air holes in the burner cap, using the back of a penknife blade. Blow off all loose carbon from wick and burner. Reassemble burner.

Fig. 16. Typical Arrangement for Storing Foods in Refrigerator.

12. CLEANING REFRIGERATOR

(a) The exterior Newtone finish of the refrigerator can be easily cleaned at any time using a damp cloth. If needed, use a small amount of mild, smooth, white soap and water. The use of a good clear automobile wax polish every six months is good practice.

(b) Fruit juices and bottled beverages which are spilled on the exterior finish should be promptly cleaned off because they will permanently stain.

(c) Grease or oil which gets on the exterior finish or on the rubber door gaskets should be promptly cleaned off because they will eventually destroy both the finish and the rubber.

(d) After removing all

shelves and the bottom food storage trays, the interior porcelain finish should be washed with a cloth wet in lukewarm soda water (1 teaspoon of baking soda to 1 quart of water). Clean food storage trays in same manner.

Fig. 17. Deep Storage Trays used as vegetable fresheners stacked at the bottom of the food compartment to provide extra space for watermelon, bulky food and tall bottles. The split shelf may be placed on the bottom of the lines as shown.

(e) Ice cube trays should be cleaned by rinsing in warm water. Shelves can be cleaned with any good soap and water, rinsed and dried.

(f) Never use abrasive material or a metal sponge to clean any part of the refrigerator surface or equipment.

13. STORING FOODS

HOT FOODS AND LIQUIDS should be cooled to room temperature before placing them in the refrigerator.

MILK AND CREAM in bottles should be placed near the freezing compartment on upper shelves.

BUTTER AND CHEESE should be wrapped in waxed paper, or kept in a covered dish, placed near the freezing compartment on a top shelf.

MEAT AND POULTRY, when uncooked, should be removed from store wrapping and cleaned, then wrapped loosely in waxed paper and placed in the meat storage tray beneath the freezing compartment or on a plate located on a shelf near the freezing unit. Cooked meat should be wrapped in waxed paper, or placed in a covered container, and stored on any convenient shelf.

Fig. 18. Deep Storage Trays removed to provide space for unusually bulky food.

FISH should be wrapped securely in waxed paper and stored in the freezing compartment. Fish is a highly perishable food, subject to rapid spoilage unless kept constantly very cold.

EGGS should be removed from cardboard cartons, placed in a wire basket or open bowl, and stored on any convenient shelf. Separated uncooked yolks and whites should be stored securely covered. The uncooked yolks should be first covered with enough water to form a thin layer over the surface because of their tendency to dry out rapidly and become leathery at the surface.

VEGETABLES should be washed, shaken to remove excess water, and stored in the deep storage tray or a covered vegetable freshener.

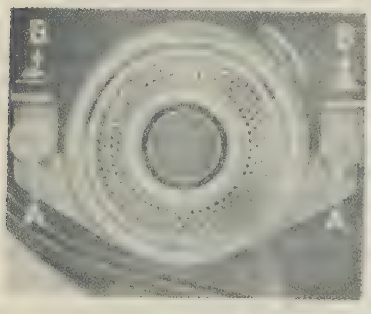


Fig. 19. Burner Screws.

ORANGES, LEMONS, LIMES AND GRAPEFRUIT can be stored in the deep storage tray or, because of their natural protective skin, may also be stored on the shelves of the refrigerator.

CANTALOUPE, PINEAPPLE AND OTHER STRONGLY FLAVORED FRUITS should be securely wrapped in waxed paper and placed in the deep storage tray.

WATERMELON, When whole, can be stored in the bottom of the refrigerator (Fig. 17 and Fig. 18) and if sliced, the cut surface should be covered with waxed paper and placed on a dish on anyyconvenient shelf in the refrigerator.

BERRIES should be removed from the box, spread on a plate and stored on any shelf in the refrigerator. They should not be washed until just before using.

BANANAS should not be stored in the refrigerator but they can be chilled there before serving.

FROZEN FOODS should be stored in the store carton, unopened, in the coldest section of the freezing compartment. Once thawed, they should be used promptly. Never try to refreeze frozen food which has been thawed.

ICE CREAM should be stored in store container in the coldest part of the freezing compartment.

LEFTOVERS should be placed in covered containers or wrapped securely in waxed paper and placed on any convenient shelf in the refrigerator.

14. REMOVING AND REPLACING BURNER

(a) Before removing burner, put out flame and allow a few minutes for the burner parts to cool off. Remove burner top, chimney support and seal lever, and glass chimney.

(b) To remove burner, remove thumb nuts "A" (Fig. 19) (Do not disturb screws "B") and lift burner from the tank.

(c) To replace burner, reverse above procedure, replacing and tightening thumb nuts "A" (Fig. 19).

Fig. 20. Wick Assembly.

15. REMOVING AND REPLACING WICK

(a) When the wick cannot be turned up high enough to obtain proper flame height, it must be replaced with a new wick.

(b) To replace wick, put out the flame and allow a few minutes for the burner parts

to cool off. Remove burner top, chimney support and seal lever, chimney and tube cap. Remove burner from tank (Par. 14). Remove wick guide by turning it to the left to unlock and lift it off the burner (Fig. 21).

(c) Turn wick as high as it will go and spring mover clamps (Fig. 20-C) outward to free holes from studs (Fig. 20-A) on wick. Slightly turn wick around burner tube to prevent studs from reentering holes in wick mover clamps.

(d) Remove wick mover (Fig. 20-C), by pulling it out through the bottom of the burner.

(e) Remove wick by pulling it out from top of burner.

(f) The spare wick sent with the refrigerator has adhesive papers at the bottom ends to afford ease of replacement by preventing fraying. Do not remove these papers until the new wick has been completely placed in the burner.

(g) A new wick should be free from moisture (water).

(h) Be careful not to fray the top of the wick during replacement.

(i) Put one of the bottom ends of the wick in one opening around the burner tube and put the other bottom end of the wick in the opposite opening around the burner tube. Push the wick ends through the burner until the ends come out at the bottom of the burner. Then pull the wick through the burner as far as possible.

(j) Replace wick mover by stuffing bottom ends of wick through the center of the mover and gently work the wick mover along the wick toward the burner, while holding the wick taut, until the wick mover rack enters guide hole. Continue to work wick mover up into the burner until the holes in the wick mover clamps can be engaged with the studs on the wick, then remove adhesive papers.

Fig. 21 - Wick guide in position for locking on burner.

(k) Replace burner on tank (Par. 14-c) and turn top of wick below top of burner tube.

(l) Replace wick guide on burner top so that the wide notch on the edge of the large flange containing holes is opposite the notch on the top edge of the burner farthest away from the wick turner (Fig. 21). Press wick guide downward and turn to the right to lock in position. Replace tube cap and seat it firmly in top of burner tube.

(m) After using the spare wick provided with the refrigerator, it would be well to order additional spare wicks (Par. 18), so that you will have them on hand when the wick next needs replacing and thus not be inconvenienced by the lack of refrigeration.

16. CLEANING KEROSENE TANK AND TANK PAN

(n) The exterior of the tank should be kept clean by wiping with a cloth. The interior of the kerosene tank will rarely need cleaning. If any foreign material or improper kerosene gets into the tank, the tank should be removed, its contents emptied, then rinse the tank out with a suitable brand of kerosene and replace (Par. 24).

PAR. 2. LOCATION

An outdoor location is subject to down or cross air drafts which will interfere with proper ventilation.

A location where the heat from stoves, radiators, registers, hot walls or the sun will warm the refrigerator cabinet, makes it harder to keep the food compartment cold.

In very cold rooms, the refrigerator may get too cold, even with the flame turned down as low as possible. If impossible to change the location to a warmer room, the burner can be turned off periodically. No damage will result to the refrigerator when exposed to severe cold.

PAR. 3. VENTILATION

The function of all household refrigerating units is to remove heat from the foods stored in the refrigerator food compartment, in order to make them cold (also, to remove heat from water to make ice), and transfer the heat so removed to the atmosphere. The heat absorbed from the food compartment by the refrigerating unit flows toward fins which are externally located on the unit and is removed therefrom by air currents passing between the fins. In the Servel unit, these fins are on pipes located at the bottom and in the rear of the unit (Fig. 31-B).

A convenient way to check the flow of ventilating air, while the refrigerator is in operation, is to blow tobacco smoke across the top toward the rear of the refrigerator. When the refrigerating unit is properly ventilated the smoke will move rapidly upward from the rear top of the refrigerator.

The space near the floor at which the air enters and the space behind the refrigerator should never be blocked and the air outlet grille should not be covered, or air flow will be retarded. If there is insufficient clearance above the top of the refrigerator, air flow will also be retarded.

Ventilating air should always be drawn from, and directly returned to, the atmosphere of the room in which the refrigerator is used, to prevent down and across drafts.

Ventilating air should not be discharged through flues to outdoor atmosphere, as down drafts will invariably result.

Down or cross air drafts due to the shape of the room and relation of open windows and doors to the refrigerator location will interfere with ventilation. Such drafts are most likely when the refrigerator is installed in the open, away from a solid wall, directly in front of or beneath a window, in an open doorway or part way through an opening in a partition.

The sides, back and top of a wall recess should be completely closed (except Par. 3-e), to prevent down or cross drafts.

PAR. 4. LEVELING

The flow of the fluids within the Servel refrigerating unit is caused by the force of gravity. The tubing of the unit is exactly sloped so that the fluids can take advantage of this force. Flow direction of the fluids is controlled by liquid traps which are automatically maintained.

Unsatisfactory refrigerator operation is very frequently caused by an unlevel refrigerating unit.

The refrigerating unit should be leveled from time to time if there is a chance of the floor sagging.

Clean frost or ice, if present, from the dessert tray shelf before leveling to get an even surface.

PAR. 7. BURNER OPERATION

It takes an hour for a new wick to suck up enough kerosene from the tank to expell all the air from the wick pores and become thoroughly soaked with kerosene. If the wick is not thoroughly soaked with kerosene, there will not be enough kerosene vapor coming off the exposed top wick surface to give the right flame.

When sealed, the top rim of the chimney should make a continuous seal against the surface of the movable asbestos seal ring attached to the refrigerating unit above the chimney, thereby making the top rim of the chimney practically air-tight (Fig. 26-E and Fig. 27-E). The flame from this Servel kerosene burner is produced by burning the kerosene vapors given off the exposed top wick surface after their mixture with the air. The air required is drawn through the air supply holes in the burner. If the chimney is not properly sealed, the right amount of air will not be drawn through the air supply holes in the burner and improper combustion will result.

The rate at which kerosene is vaporized from the exposed top surface of the wick and the rate at which air is drawn into the air supply holes in the burner and mixed with the kerosene vapor, depends on burner and flue temperatures. As these temperatures go up, more kerosene is evaporated and more air is drawn into the burner. This causes a change in flame size and appearance. Therefore, whenever the burner is shut off, and the burner, flues and other metal parts are allowed to cool, these parts must be first heated up to operating temperature in order to cause a balanced condition of temperatures, flue draft, fuel vaporization and air mixture; otherwise, the flame will not be stable and its adjustment will not be permanent.

At altitudes in excess of 8,000 feet, it may be necessary to close some or all of the six large holes on the sides of the burner top, in order to get satisfactory refrigeration. These holes can be closed by using a collar of tin on the inside of the burner top. The rarified air at such altitudes does not contain as much oxygen as the air at sea level. In order to burn enough kerosene vapor to get the right heat input to the unit, it is necessary to supply the burner with a greater volume of rarified air to get the required amount of oxygen for combustion. Closing the holes causes a greater draft, which pulls the greater volume of air through the burner air supply holes.

Carbon on the wick will increase kerosene odors when the refrigerator is operated with the flame turned down low.

When carbon deposits are hard and excessive, they may bridge across the top of the wick adhering to the flange of the wick guide, or to the tube cap, making it impossible to turn the wick up or down.

PAR. 8. FOOD STORAGE COMPARTMENT

The upper air in the closed refrigerator is cooled by contact with the cold exterior of the freezing compartment. When this air is cooled it contracts in volume and becomes relatively heavier than the less cold lower air. Therefore, the cold air at the top moves downward around the foods, cooling them by contact. At the same time, the less cool air at the bottom is pushed up along the sides of the food compartment and finally reaches the freezing compartment. Here it is made cold, moves downward, and the air circulation cycle is repeated.

PAR. 9. ICE CUBES

Do not use hot water to make ice cubes as it takes so much longer to freeze.

PAR. 10. DEFROSTING

Trays stuck because of frost are frequently permanently damaged when forcibly removed by the use of tools.

Defrosting the day before storing the week-end food supply will prepare the the refrigerator to efficiently cool the extra load.

PAR. 11. CLEANING WICK AND BURNER

Kerosene is a mixture of various petroleum oils. Some of these oils cannot be vaporized by a wick type burner and, therefore, they remain unburned in the form of carbon. The longer the burner is operated without cleaning, the greater is the amount of carbon formed. Continued exposure to the heat from the burner causes carbon to bake and become hard.

Carbon deposits on the exposed top wick surface partially seal the wick pores, thereby blocking kerosene flow and reducing the amount of kerosene which can be vaporized by the burner. Such deposits on the wick, on the flange of the wick guide and on the surface of the tube cap clog the burner air holes and reduce the supply of air to the flame. They also prevent the air from properly mixing with the kerosene vapors.

Reduction in amount of kerosene vapor and air, and their improper mixture reduces the flame in size and changes its color from blue to partial or complete yellow. The complete effect of increased carbon accumulation is to reduce flame size and change flame characteristics, reduce heat input and refrigeration effect until the flame finally goes out and refrigeration stops. In this condition the burner will not light nor stay lighted.

When carbon is allowed to accumulate and get hard on the top of the wick, the carbon will penetrate the wick pores and adhere to the wick fabric. it is then impossible to remove the carbon without tearing some wick fabric which may ruin the shape of the wick.

Carbon causes the flame to burn so near the wick surface that the wick also burns. This shortens wick life.

18. ESSENTIAL SERVICE PARTS FOR REFRIGERATOR

MODELS N-603 and N-803

Part Name	*Part Number*
Complete Burner	5396-248
Tube Cap	5408-12
Wick	5383-7
Glass Chimney	5398-23
Kerosene Tank	5930-51
Door Gasket	
Refrigerator Model N-603	2139-254
Refrigerator Model N-803	2139-249
Door Hinge	3521-60
Latch Mechanism for Right Hand Door (R.H.D.)	3500-26
Latch Mechanism for Left Hand Door (L.H.D.)	3500-27

Note: If door hinges are on right hand side when facing front of cabinet, use R.H.D. latch mechanism; if door hinges are on left hand side when facing front of cabinet, use L.H.D. latch mechanism.

	Model Number
Refrigerating Unit	
Refrigerator Model N-603	RUN-603
Refrigerator Model N-803	RUMN-803

19. CLEANING FLUE SYSTEM

(a) The Servel refrigerator flue system (Fig. 22) contains the following interconnecting flues: The generator flues, flue elbow, lower flue pipe and upper flue pipe.

(b) The continued passage of air and combustion products through the flue system during refrigerator operation draws into and deposits on flue surfaces a certain amount of dirt, dust, lint, etc. If the burner flame smokes, soot will also be deposited. Any accumulation of foreign material which blocks the flues, reduces the draft, causes poor refrigeration and should be cleaned out. The need for cleaning the flue system is very infrequent and depends entirely upon operating conditions.

(c) The generator flues, of which there are seven (Fig. 23), each having a comparatively small opening are therefore, more likely to show the first need for cleaning in the flue system. For this reason the generator flues should be examined first. Before examining the generator flues, unseal the chimney, pull the tank forward as far as it will go and blow out the flame. Allow a few moments for the burner parts to cool off and then spread a newspaper over the tank pan beneath the generator. Securely loop one end of a length of wire around a piece of cloth and push up a generator flue far enough to pass out at the top of the flue into the flue elbow. Rotate cloth so as to clean top generator crown sheet and pull it down and out at the bottom of the flue. If the cloth is clean, it may be concluded that

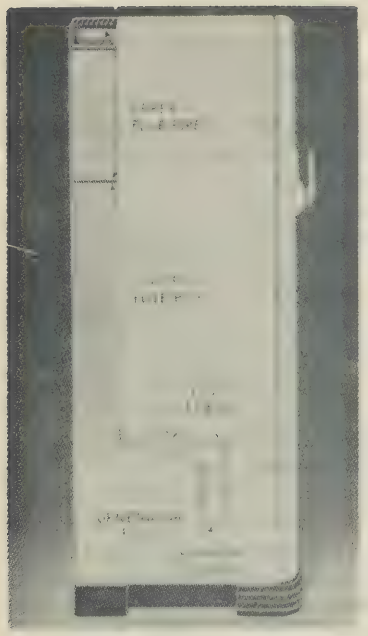


Fig. 22. Flue System, Refrigerator Models N-603 -- N-803.

the flue system is clean. If the cloth is dirty, clean the flue system.

(d) In order to clean the flue system, move refrigerator away from wall far enough to remove the back panel from the refrigerator. Remove the back panel by loosening ten screws "A" (Fig. 24). Remove two screws marked "B" (Fig. 25), which fasten lower flue to refrigerator and remove lower flue. With a cleaner made with a length of wire and a piece of cloth (or a bottle bursh), clean all dirt from inside of lower flue. In the same manner clean the upper flue pipe without removing it from refrigerator.

(e) Clean the flue elbow while the lower flue is removed. Push a cloth attached to a piece of wire into the flue elbow from the rear of the refrigerator, working the cloth back and forth. This will loosen any dirt and cause it to fall down through the generator flues onto the newspaper.

(f) Clean all of the generator flues in the manner described in Par. 19-c.

(g) While the rear panel is removed from the refrigerator, examine pipe fins in rear of refrigerator to see if they are in need of cleaning. If so, they should be cleaned (Par. 20) before replacing the back panel.

(h) When the cleaning of the flue system has been completed, replace the flues and and back panel by reversing the procedure described above.

20. CLEANING PIPE FINS

(a) In some locations, grease, dirt or lint will accumulate on the pipe fins located in the rear at the top of the refrigerator and on the pipe fins located in the burner compartment (Fig. 31-B). These deposits act as an insulator retarding the rate at which heat is absorbed from the fins by the ventilating air. The effect is to reduce refrigerating capacity, resulting in slow freezing and higher cabinet temperatures.

(b) In order to clean the pipe fins at the rear of the refrigerator, the refrigerator should be moved away from the wall and the back panel removed as described in Par. 19-d. The fins should be cleaned with any long-handled brush such as a hair brush, bath brush or radiator brush. Large accumulations of grease on the fins can be removed by the use of carbon tetrachloride and brush or cloth.

(c) After the fins have been cleaned, the rear panel should be replaced reversing the procedure described in Par. 19-d.

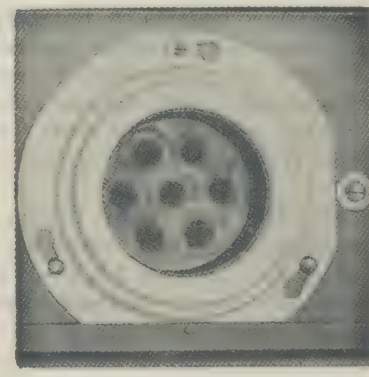


Fig. 23. Generator Flues, Refrigerator Models N-603 -- N-803.

21. CHIMNEY SEAL ADJUSTMENT

(a) Attached to the refrigerating unit above the burner chimney, around the generator flue opening is a

movable asbestos seal ring (Fig. 26-B and Fig. 27-B). In order for the refrigerator to operate properly, the top rim of the glass chimney should make a continuous seal against the surface of the movable asbestos seal ring. The refrigerators are adjusted at the factory so that the chimney can be sealed by a forward movement of the chimney seal lever (Fig. 10). When the chimney seal lever is in its forward or sealed position, the top rim of the glass chimney should raise the movable asbestos seal ring slightly from its supporting bracket. To allow for slight structural variations, the burners are provided with an adjustment which makes it possible to vary the height of the burner in relation to the tank.

Fig. 24. Rear Panel Screws. Fig. 25. Rear Panel Removed

(b) The burner height setting is fixed at the factory and will rarely have to be changed. This adjustment can be made by loosening screws "B" (Fig. 19), retightening them when the proper burner height has been obtained.

(c)) The burner and chimney should be centered with the movable asbestos seal ring to afford proper sealing. This adjustment is made at the factory and will rarely have to be changed. The chimney seal can be conveniently examined by using a small mirror in one hand and a flashlight in the other. To adjust the burner toward either side of the refrigerator, it is necessary to shift position of the tank sideways. Loosen the nut on the tank pivot pin attached to the tank pan in rear corner. The tank can now be moved slightly toward either side of the refrigerator, after which the pivot pin nut should be tightened to fix the pivot pin in position. To adjust the burner toward either the front or the back of the refrigerator, change the position of the stop screw, which can be adjusted from the rear of the refrigerator after loosening the lock nut which holds this screw in place.

22. DOOR SEAL ADJUSTMENT

(a) While the food compartment door is closed, there should be an air-tight point between the door and the front of the cabinet to prevent the cold air from leaking out of the food compartment. This joint or seal is maintained by means of a resilient rubber gasket attached to the inside edge of the door. If the door seal leaks, the continuous loss of cold air from the food compartment and its replacement by infiltration of warm room air will impose an added load on the refrigerator which has a tendency to make the refrigerator less cold and increase the time of freezing ice cubes.

(b) Failure of the gasket to contact the front of the cabinet can be determined visually when the door is closed and latched. As a check for lack of contact, a paper match cover should pass between the gasket and the cabinet front with no drag.

Generator flue opening with movable asbestos seal ring and seal supporting bracket removed.

Asbestos movable seal ring.

Seal ring supporting bracket and retaining screw.

Movable seal ring assembled to the refrigerating unit.

Seal lever in sealed position, affording continuous seal between the top rim of the chimney and movable asbestos seal ring.

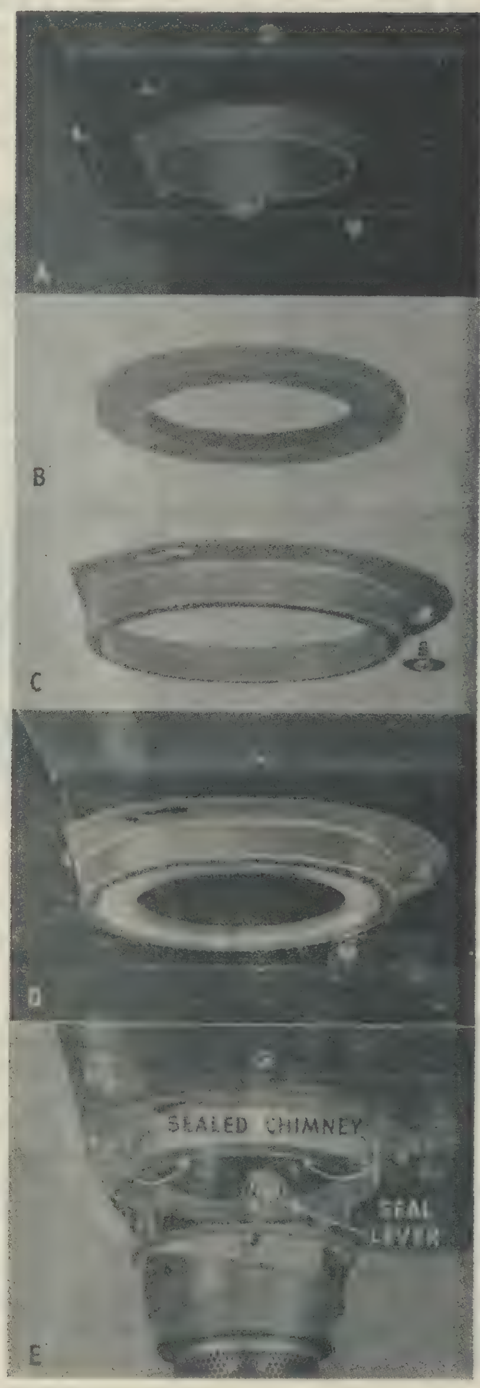


Fig. 26. Seal Ring Assembly, Refrigerator Model N-603.

Generator flue opening with movable asbestos seal ring and seal supporting bracket removed.

Asbestos movable seal ring.

Seal ring supporting bracket and retaining screw.

Movable seal ring assembled to the refrigerating unit.

Seal lever in sealed position, affording continuous seal between the top rim of the chimney and movable asbestos seal ring.

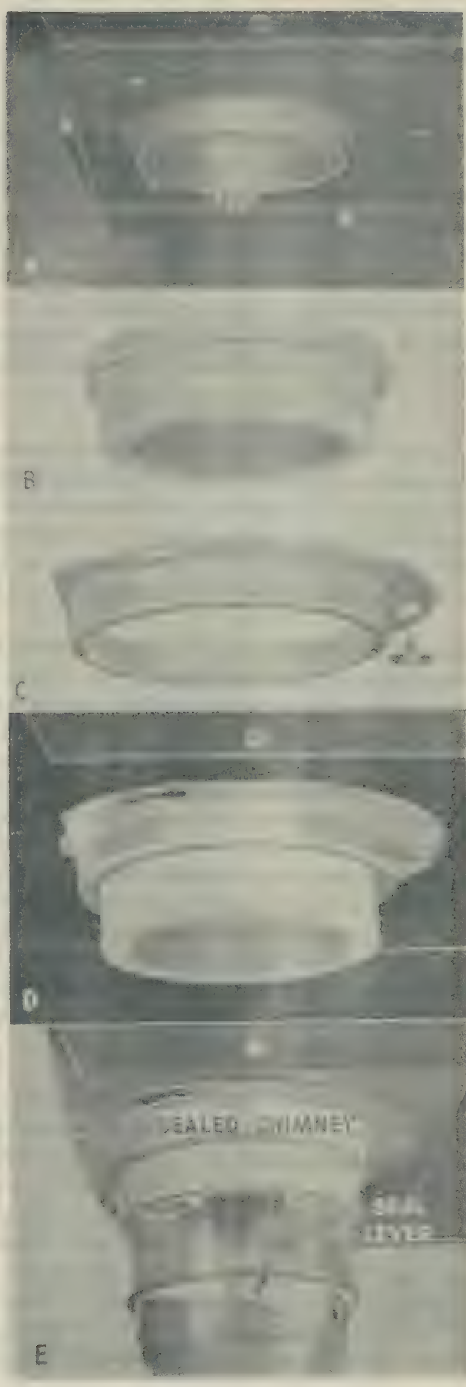


Fig. 27. Seal Ring Assembly, Refrigerator Model N-803

A leak will be indicated while the refrigerator is in operation, by drops of water forming on the cabinet door opening trim, at the place suspected.

(c) The causes for faulty door seal are insufficient or uneven door pressure and uneven door gasket thickness.

(d) The door pressure can be regulated by adjustment of the latch striker. The two screws which hold the striker bracket against the striker plate permit a side to side adjustment which primarily controls the amount of latch bolt engagement. In this respect, the striker should be adjusted so that the bolt when full disengaged by pulling the handle out, just clears the striker as the door is opened and closed. The two screws holding the striker to the striker bracket permit and in-and-out adjustment of the striker and control the amount of pressure which the door exerts on the door gasket. The pressure is increased by moving the striker inward and decreased by moving it outward. The striker should be fastened in that position which will cause just enough pressure on the door gasket to give a complete door seal.

(e) A leaky door seal may result from a twisted door which when closed causes uneven gasket pressure. A twisted door may be detected by closing it as far as possible without latching and comparing the latch side edge with the front of the cabinet. The latch side edge of a properly assembled door should be parallel with the front of the cabinet. A door twist is caused by improper replacement of a door pan and may be corrected as described in Par. 25-g.

(f) Uneven thickness of the gasket may result from aging or may be due to deterioration. One of the greatest enemies to rubber gaskets is the grease and oil which may get on the gasket by careless handling of the refrigerator while preparing foods or handling dishes. Such grease or oil should be promptly washed off the gasket with soap and warm water. If grease and oil are allowed to remain on a rubber gasket, it will deteriorate, reducing resiliency and thickness to the extent that a door seal leak will result. If a slight reduction in gasket thickness is the cause of the leak, it can be corrected by adding adhesive tape on the door behind the gasket at the point of leakage. If the gasket is badly aged or deteriorated, it should be patched by inserting a section of gasket where needed, or completely replaced.

Fig. 28. Burner placed on tin can for charring wick.

23. CHARRING THE WICK

(a) A clean wick will need charring only when its top edge is so uneven that it causes a very irregular flame with yellow tips.

(b) Before charring wick, put out flame and allow a few minutes for the burner parts to cool off. Remove burner from tank (Par. 14).

(c) If wick is dry, turn it up so that its top is about ¼" above top of the burner tube (Fig. 20-B) and soak exposed top of wick in kerosene for about five minutes.

(d) Lower wick so that the lowest point of its top uneven edge is level with top of the burner tube.

(e) Insert the bottom ends of the wick in an empty, clean tin can, allowing the

burner to rest on the top of the can (Fig. 28), in an outdoor location, free from strong drafts. Light wick and let it burn until the flame burns out. The wick should have then burned or charred down even with the top of the burner tube. If the flame blows out during the charring process, it should be relighted and allowed to burn out. (It may be necessary to dip the charred top of the wick in kerosene before it can be relighted and allowed to burn out.)

(f) Brush away the wick ash above the top of the wick guide with the fingers, blowing off any loose carbon ash which remains. Turn wick up so that the unburned portion of the wick is visible above the wick guide top. Shape the top of the wick using the thumb and forefinger (Fig. 14) with a pinching action, drawing the fingers upward from the wick and slightly shaping the wick top inward.

(c) Replace burner on tank (Par. 14). Allow at least one hour for the wick to become soaked with kerosene before lighting. Then light burner. When wick is relighted after cleaning, the flame may contain yellowish flashes and streaks until all the bits of the carbon left from the cleaning operation have been burned.

24. REMOVING AND REPLACING TANK

(a) In order to remove the tank from refrigerator model N-603, it is necessary first to move the refrigerator forward so that there is at least 8" clearance between the rear of the refrigerator and the wall. When moving the refrigerator, be careful not to spill kerosene out of tank. The tank can be removed from the N-803 model without disturbing the position of the refrigerator.

(b) Before removing tank, remove the burner (Par. 14). Raise right end of tank to free pivot bracket (Fig. 6) from pivot pin, and swing this end of the tank back through the opening in bottom rear of the cabinet. Then slide the left end of the tank forward between the front legs of the refrigerator,,being careful not to damage the kerosene gauge or spill kerosene.

(c) Before replacing the kerosene tank, thoroughly clean the tank pan.

(d) If the refrigerator has been in use, it would be well to examine the flue system and clean if necessary (Par. 19) before replacing the kerosene tank.

(e) To replace tank, push the end of the tank to which the pivot bracket is attached between the front legs of the refrigerator. Push the tank completely under the refrigerator and swing the pivot bracket end of the tank to the right and slip pivot pin in hole in pivot bracket, and replace burner (Par. 14).

(f) After replacing the tank and moving the refrigerator back into operating position, check the level of the refrigerating unit.

25. REMOVING AND REPLACING DOOR LATCH

(a) In order to remove door latch mechanism, remove two screws "A" from door stop and opener (Fig. 29).

(b) Remove all door pan screws located under door gasket, removing last the top center screw. Remove door pan with door gasket in place, while pulling latch handle back as far as possible to disengage latch bolt from door pan latch bolt trim plate.

(c) Remove insulation from door.

(d) Remove screws "A" and "B" (Fig. 30) on top surface of cross channel attached to latch mechanism and similar screws directly beneath on the bottom surface of the

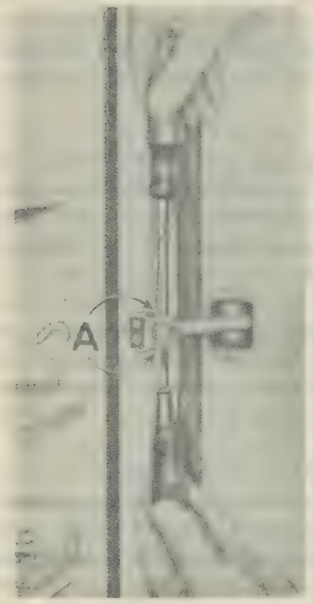


Fig. 29. Removing Door Stop and Opener.

cross channel. Remove cross channel by first disengaging from latch and pulling the other end from yoke bracket.

(e) Remove two screws "D," holding latch mechanism to door cover flange and screw "E" from door latch mechanism plate (Fig. 30). Remove latch mechanism.

(f) To replace latch mechanism, reverse the procedure in Par. 25-e, -d and -c.

(g) Replace door pan with gasket in position, replacing first the top center screw. Line up screws with holes in gasket and door pan at the bottom of the door, adjusting gasket so that the two gasket ends butt in a flush joint, at the same time adjusting gasket on the hinge side of the door to obtain a good fit. Replace the screws, not too tightly, working from the bottom of the pan up each side of the door and finally at the top, adjusting the gasket when necessary, as the screws are replaced, to give the proper gasket fitting. After the door pan screws have all been replaced, before finally tightening, check the alignment of the door with the cabinet by closing the door as far as possible without latching. The latch edge of the door should be parallel with the front of the cabinet. If not parallel, it should be made so by slightly twisting the latch side of the door, using the knee and hand in opposite directions. When the door alignment is correct, finally tighten all door pan screws. Do not draw up screws so tightly that they cause the door pan edge to buckle and raise sufficiently to allow air leakage into the door insulation. If air leaks into the door insulation, the moisture from the atmosphere of the room will cause the insulation to become wet, reducing its insulating effectiveness.

(h) Reverse procedure in Par. 25-a.

(i) Check door seal (Par. 22).

26. REMOVING AND REPLACING DOOR HINGES

(a) In order to remove door hinges, remove two screws "A" from door stop and opener (Fig. 29). Remove the lower two screws holding the top hinge to the cabinet. Remove three screws holding the lower hinge to the cabinet. Remove remaining screw holding top hinge to cabinet and remove door.

(b) Place door, gasket side up, on table or floor using means to protect the outside door finish from damage.

(c) Remove door pan and gasket (Par. 25-b).

(d) Pull sealing tape from hinge to be removed and remove three screws holding hinge to door.

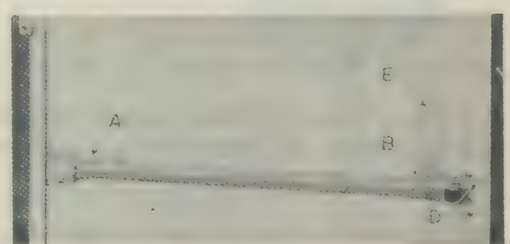


Fig. 30. Door Latch Mechanism and Cross Channel, located inside door.

(e) To replace the hinges and door:

Reverse the procedure in Par. 26-d.

Replace pan and gasket (Par. 25-g).

Reverse the procedure in Par. 26-b and Par. 26-a.

Check door seal (Par. 22).

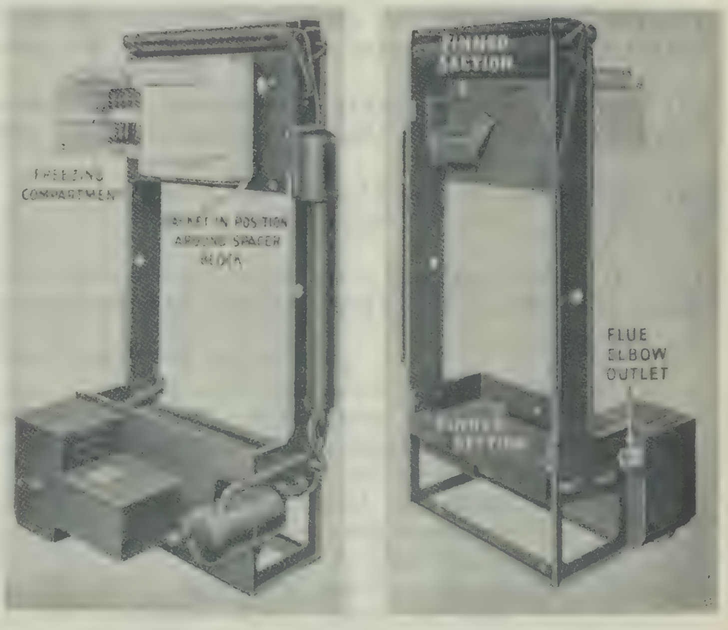
27. REMOVING AND REPLACING DOOR GASKET

(a) Remove door pan (Par. 25-a and Par. 25-b) and replace gasket. Four locating screw holes are punched in the replacement door gasket. The remaining holes should be punched with a sharp point to match the screw holes in the door cover flange, while the screws are being replaced in the door pan.

(b) Replace door pan (Par. 25-g).

(c) Reverse procedure in Par. 25-a.

(d) Check door seal (Par. 22).



A -- Front View. B -- Rear View.

Fig. 31. Refrigerating Unit, Controls and Accessories Removed.

28. REMOVING AND REPLACING UNIT

(a) Unseal the glass chimney by moving the seal lever (Fig. 7) backward as far as it will go.

(b) Remove all ice cube trays from the freezing compartment.

(c) Remove freezing compartment front baffle, after prying out the side pins attaching the baffle to the freezing compartment.

(d) Remove food shelves and shallow storage tray.

(e) Move refrigerator away from wall so that the back of the refrigerator is accessible.

(f) Remove back panel and lower flue (Par. 19-d).

(g) Remove seven hex head bolts "C," lock washers and washers (Fig. 25), which attach unit to cabinet.

(h) Lift the unit out of the rear of cabinet carefully to avoid striking the porcelain liner with the freezing compartment and also damaging the

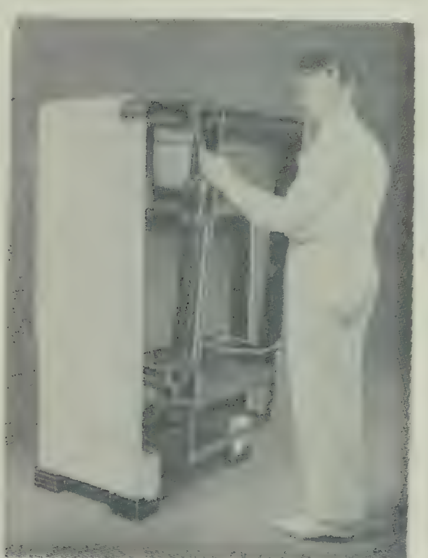


Fig. 32. Removing Refrigerating Unit.

interior light bulb. In removing the unit, be careful that the interior light cord extension is not entangled with any part of the unit.

(i) Before replacing unit, remove gasket from spacer block of the unit replaced and install same on spacer block of replacement unit (Fig. 31-A).

(j) Lift unit into position (Fig. 32) and replace by reversing the procedure given in Pars. 28-g, -f, -e, -d, -c, and -b.

(k) After the unit has been installed and the refrigerator moved back into operating position, check the level of the refrigerating unit.

29. DOES NOT GET COLD ENOUGH

(a) Improper location (Par. 2).
(b) Improper ventilation (Par. 3).
(c) Refrigerator not level (Par. 4).
(d) Improper food storage (Par. 8-b).
(e) Excessive load (Par. 8-c).
(f) Improper door seal (Par. 22).
(g) Needs defrosting (Par. 10).
(h) Improper flame adjustment (Par. 7).
(i) Wick or burner needs cleaning (Par. 11).
(j) Needs wick replacement (Par. 15).
(k) Improper chimney seal (Par. 7-g and Par. 21).
(l) Flue system needs cleaning (Par. 19).
(m) Improper kerosene (Par. 5).

30. GETS TOO COLD

(a) Wick turned up too high (Par. 7-k).
(b) Improper location (Par. 17, Note 3).

31. WILL NOT GET COLD AT ALL

(a) Burner flame out:
  Wick or burner needs cleaning (Par. 11).
  Wick turned too high or too low (Par. 7-j and Par. 7-k).
  Kerosene tank empty (Par. 6-f).
(b) Improper burner lighting (Par. 7-n).
(c) Failed refrigerating unit:
  Replace unit (Par. 28).

32. KEROSENE ODORS

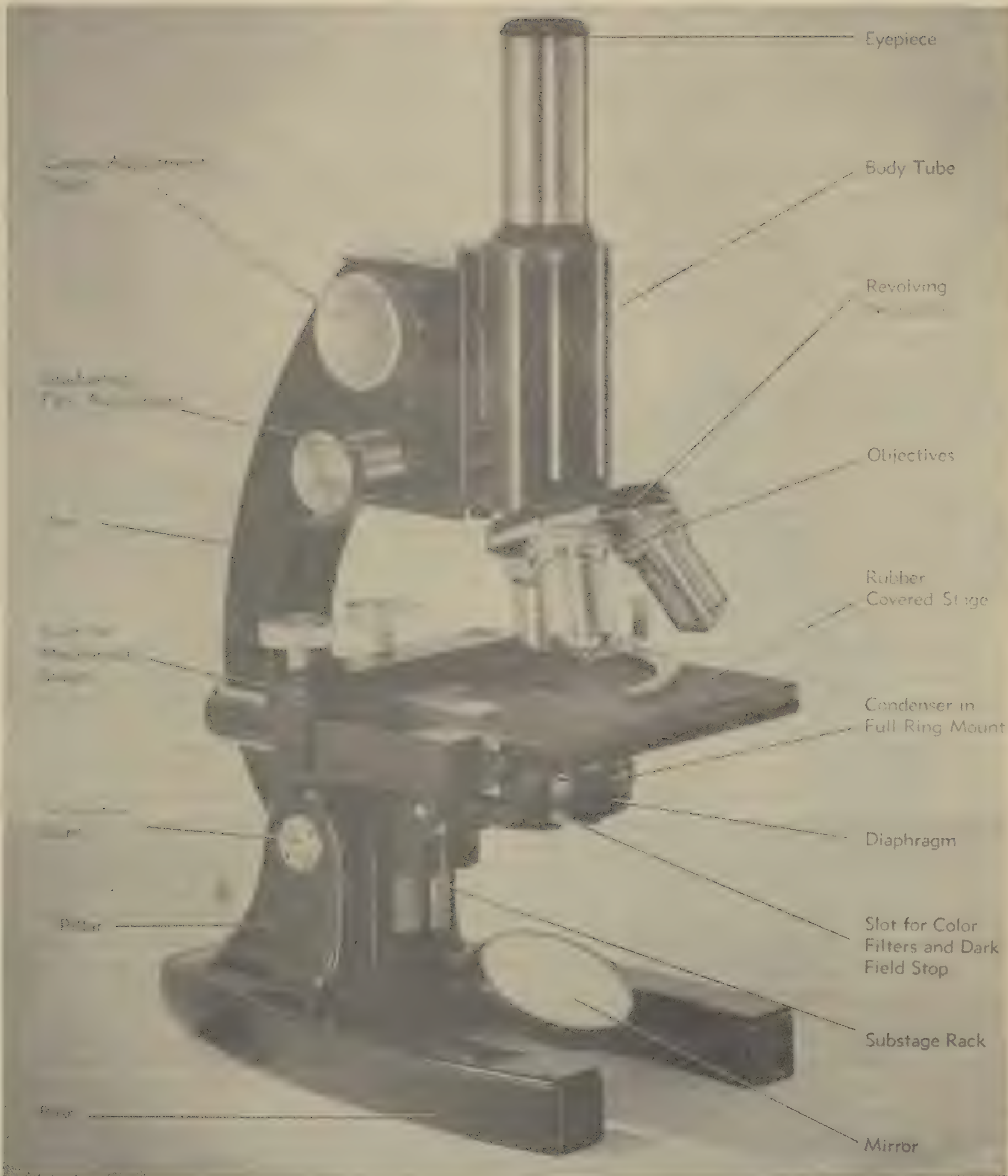
(a) Low flame (Par. 7-k).
(b) Wick or burner needs cleaning (Par. 11).
(c) Improper kerosene (Par. 5).

CHAPTER XII

MISCELLANEOUS

SECTION 4

MICROSCOPES


Eyepiece
Body Tube
Revolving
Objectives
Rubber
Condenser in
Full Ring Mount
Diaphragm
Slot for Color
Filters and Dark
Field Stop
Substage Rack
Mirror
Pillar

MICROSCOPES

BASIC INFORMATION

THE MICROSCOPE - The modern compound microscope as used in medical work represents coordinated mechanical and optical precision. One without the other is more or less useless. Accordingly, the leading makers endeavor to provide the maximum of efficiency, convenience, and utility in both.

MECHANICAL STRUCTURE

STAND - The microscope for medical use should have a stand large and heavy enough to give the necessary stability and to support the instrument when it is used inclined.

STAGE - A large square stage is usually more convenient, although for micro-chemical diagnostic methods a round rotating stage is useful.

MECHANICAL STAGE - A mechanical stage is desirable for the controlled movement of a preparation when making blood counts, or to make certain that the entire area of a smear has been searched. Most medical microscopes are supplied with a built-on mechanical stage. Mechanical stages may be added to a microscope with a plain stage at any time.

SUBSTAGE - The condenser is usually mounted below the stage, and is focussed up and down by a rack and pinion. Several mountings are possible for the condenser. Dark field condensers are interchangeable with bright field condensers.

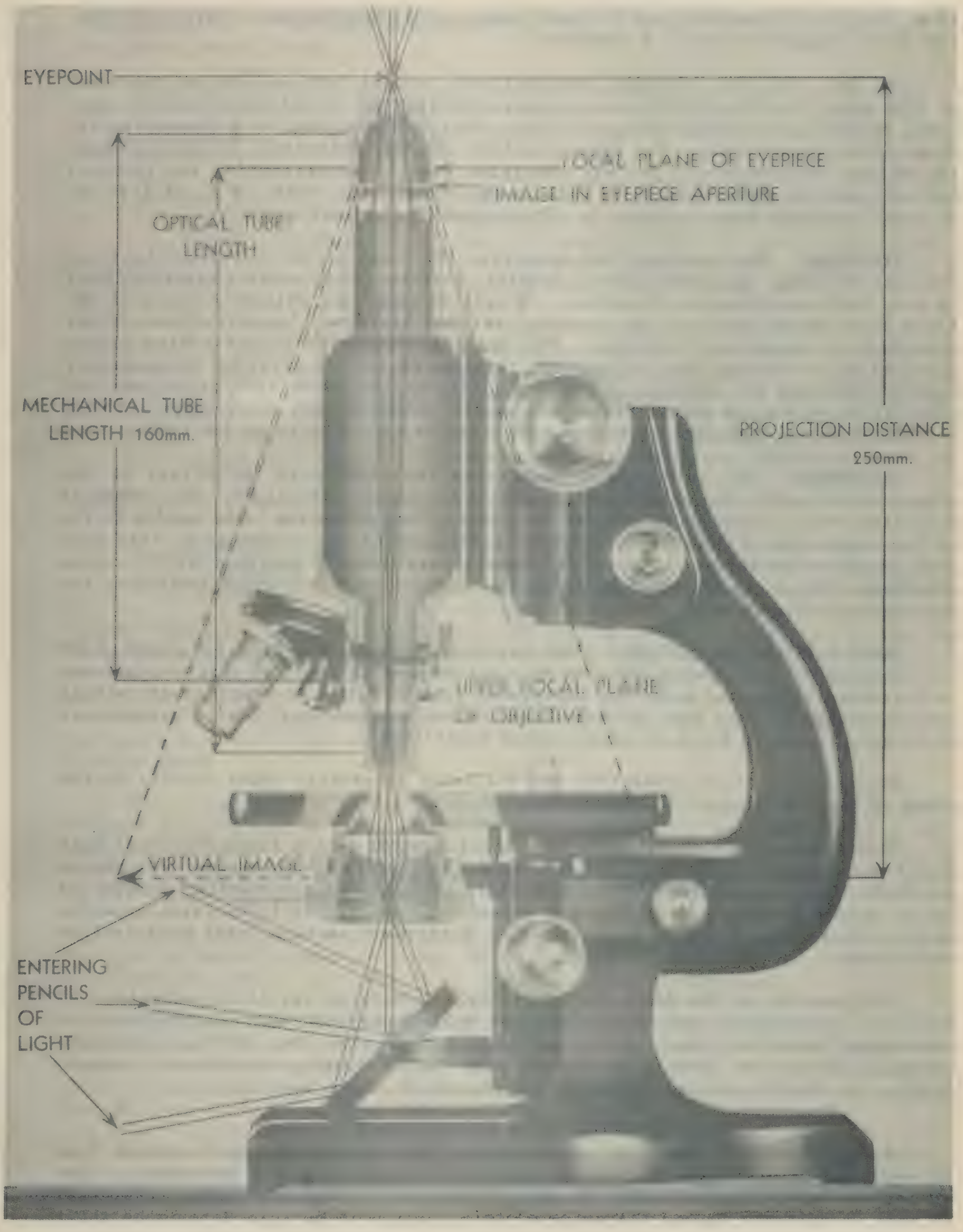
FOCUSSING ADJUSTMENTS - Rapid raising or lowering of the body tube or coarse adjustment is effected by a rack and pinion. Final and precise focussing is effected by very slow vertical movement of the body tube by the fine adjustment. Very delicate movement is essential when using the higher power lenses and the fine adjustment should be designed for positive movement throughout its range, and to withstand the wear of constant usage.

MAGNIFICATION - Visual magnification in the compound microscope is the result of further enlargement by the eyepiece of an enlarged aerial image formed by the objective. It is only useful as it enables more detail to be seen. Magnification that does not increase the detail is called empty magnification. The limit for useful magnification in visual work is approximately 100 times the numerical aperture of the objective. Accordingly, with achromatic objectives the useful limit is about 1200X. Magnifications higher than this are sometimes convenient and in certain photomicrographic and measurement problems, may be useful.

RESOLUTION - The resolving power of a lens is its ability to reveal fine detail and is stated as the least distance between two lines or points, at which they are seen as two, rather than as a single blurred object. The resolving power is a function of the wave length of light used and the greatest angle of two rays of light that may enter the front lens of the objective upon which the Numerical Aperture (N.A.) depends.

OBJECTIVE LENSES - Three kinds of objective lenses are available. Achromatic objectives are usually placed on microscopes for medical and general work, because they give good definition and are adequately corrected for all but the most critical work. Fluorite objectives have additional correction and are useful when extreme optical perfection is not required. The apochromatic objectives are most completely corrected and they are normally used for advanced, research microscopy.

The low power, 16mm. objective is usually separable so that the front lens system may be removed, leaving a useful low power lens for the examination of large sections, or whole mounts of embryos. The initial magnification of the complete


EYEPOINT
FOCAL PLANE OF EYEPIECE
IMAGE IN EYEPIECE APERTURE
OPTICAL TUBE LENGTH
MECHANICAL TUBE LENGTH 160mm.
PROJECTION DISTANCE 250mm.
VIRTUAL IMAGE
ENTERING PENCILS OF LIGHT

16mm. lens is 10 diameters, and the back lens system alone becomes a very good 32mm. lens with a magnification of 4 diameters.

Two 4mm. high dry objectives are available, one of 0.65 or 0.66 and the other of 0.85 N.A. The latter will resolve greater detail, but is not often used in medicine, because its working distance is too short for focussing on a Haemacytometer when making blood counts. The magnifications of these objectives are respectively 43, 44 and 45 diameters. The oil immersion lens is necessary for the study of bacteria and the finer details of cells. The 1.8mm. lens, with a N.A. of 1.25 and 95 or 97 diameters magnification, is often chosen for medical work.

EYEPIECES - The eyepiece both magnifies the image of the objective lens and corrects the image for aberrations. Special, corrected compensating eyepieces must be used with apochromatic objectives. Widefield eyepieces extend the area of the field when large sections are examined as when blood and bacterial smears are searched for evidence of disease. The magnification of any combination may be obtained by multiplying the initial magnification of the objective by the secondary magnification of the eyepiece. Two eyepieces, one of about five or six and the other of ten diameters magnification are usually supplied when microscopes are used in medical work. Eyepieces of higher magnification may be obtained for special work.

CONDENSER - The condenser concentrates the light onto the object at the proper angle to fill the objective lens of the microscope with light. The condenser must have an N.A. equal to or greater than that of any objective to be used with it. or the resolution will be limited by the inadequacy of the condenser to less than that of the objectives. Medical microscopes are usually equipped with an Abbe condenser. The angle of the light to suit the objective in use is controlled by the substage iris diaphragm.

DARK FIELD ILLUMINATION - Dark Field Illumination refers to a method of illuminating the specimen at the apex of a hollow cone of light so that the specimen is brightly illuminated while the background remains dark. The dark field methods take advantage of this fact to show objects which are too small or too transparent to be seen in bright field, or which cannot be stained.

Special dark field condensers are available in several types for use in the place of the usual bright field condenser.

To expedite the work of those laboratories which make a large number of dark field observations, instruments designed for dark field work exclusively can be supplied. On these instruments the dark field condenser is permanently centered and has an attached light source, thereby eliminating the necessity of "setting up" a regular microscope for this work. Such an instrument saves a great deal of time and trouble.

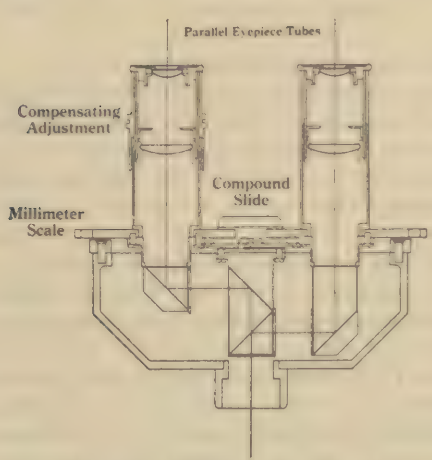
The program of the American Public Health Service for the eradication of Syphilis is becoming generally effective throughout the country. The medical profession has established uniform methods of diagnosis. One of the most widely accepted and positive methods employs the dark field microscope technique in searching for the living organism Treponema pallidum which causes syphilis.

THE BINOCULAR MICROSCOPES

These are of two kinds, (1) the mon-objective type and (2) the Greenough type in which two complete microscopes are assembled into a binocular instrument. (See following two illustrations.) So many forms of the Greenough type exist that it will be entirely beyond the scope of this section to go into details of their

manipulation. The instructions given here will, therefore, be only such as are applicable to all forms.

DIFFERENCE BETWEEN MONOCULAR AND BINOCULAR MICROSCOPES - In manipulation they differ principally in the added requirement that each eye must see its own field of view and the two images must be fused into a single binocular view in the same way that your two eyes give you a single image of a pencil lying on your desk. In results they differ in that the binocular permits long periods of observation with less fatigue than the monocular type of instrument, and the Greenough type, in particular, gives a stereoscopic image which is extremely useful in examining many kinds of objects.



Binocular Eyepiece Attachment for Mon-objective Microscope

MANIPULATION - It differs from the manipulation of monocular instruments in that two additional adjustments have to be made, an adjustment of the separation of the two eyepieces to adapt it to the distance between the observer's eyes (his interpupillary distance) and, sometimes, a separate focus adjustment of one of the eyepieces caused by small differences in the refraction of the observer's eyes.

ADJUSTMENT FOR INTERPUPILLARY DISTANCE - In the mon-objective type illustrated on this page the distance between the eyepiece tubes can be adjusted by pulling them apart or pushing them closer together. A millimeter scale is provided by means of which the observer can note the correct setting after the adjustment has once been made, and thereafter he can make the adjustment by merely setting to the known scale reading.

In the Greenough type grasp the prism boxes with both hands and rotate simultaneously in opposite directions. This will move the eyepieces closer together or farther apart.

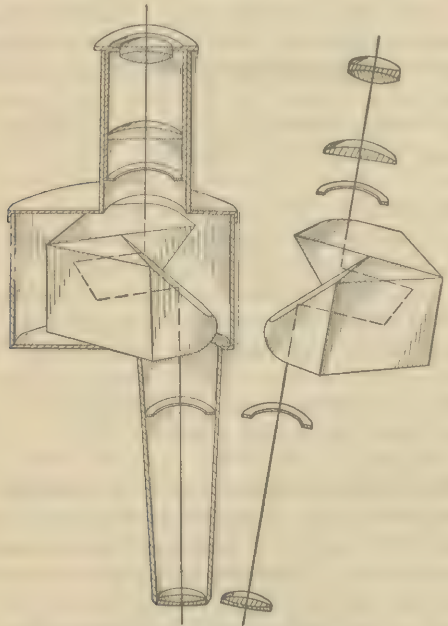
The adjustment for interpupillary distance is important. If not carefully carried out, you may be getting binocular vision in only a small part of the field and nothing more than monocular vision in the rest. When you think you have an approximate adjustment, test by alternately obscuring the eyepieces either by alternately closing the eyes or by using two cards. After one eye has been closed, an impression remains for a part of a second and if the other eye is uncovered immediately it is possible to become conscious of the two fields simultaneously. If each eye is seeing a complete field, the adjustment is practically complete. Vision with both eyes should now result in a completely fused single image.

ADJUSTMENT FOR DIFFERENCES OF FOCUS BETWEEN THE TWO EYES - In the mon-objective type one eyepiece is provided with a focusing collar to permit independent focusing of that one eyepiece. Focus the instrument first for the eye used over the fixed eyepiece and then, if the image seen by the other eye is not sharp, it can be brought into focus by means of this adjustment collar.

In the Greenough type (the K class of microscopes) small differences between the two eyes can be compensated in a similar manner by withdrawing one of the eyepieces a small distance out of the tube. Friction will hold it in place.

Final adjustment of focus should be made after adjustment for interpupillary distance has been completed.

EYEPIECES AND OBJECTIVES - The eyepieces used in both types and the objectives used in the Greenough type must be paired. Otherwise the images would lie in different planes and would be of different sizes and binocular vision would be impossible or possible only at the expense of serious eyestrain.



Arrangement of Lenses and Prisms in Greenough Type Binocular Microscope

CARE OF MICROSCOPE

Besides acquiring the ability to use an instrument properly with its accessories, it is important to know how to keep it in the best working condition. It may be said without reserve that an instrument properly made at the outset and judiciously used should hardly show any signs of wear, either in appearance or in its working parts, even after the most protracted use.

Especial care should be given to the optical parts, in fact such care that they will remain in as good condition as when first received, after any amount of use.

The fine adjustment, particularly, causes the greatest difficulty, as in some instruments the movement of the fine adjustment is in a direction opposite to that of the micrometer screw, and thus the objective as well as the object is endangered.

If the microscope is to be carried any distance, it should be placed in its case.

CARE OF THE STAND - *Keep free from dust is one of the first rules to be observed.* When not in use place the microscope in its case, or cover with a bell jar or close-mesh cloth such as cotton flannel or velvet which should reach to the table. If dust settles on any part of the instrument, remove it first with a camel's hair brush and then wipe carefully with a chamois skin, wiping with the grain of the finish of the metal and not across it, as in the latter case it is likely to cause scratches.

When handling the stand, grasp it by the pillar or handle arm. While the arm is the most convenient part, it is at the same time the most dangerous to the fine adjustment, except in instruments of the handle-arm type.

Avoid sudden jars, such as placing upon the table or into the case with force.

Remove any Canada balsam or cedar oil which may adhere to any part of the stand with a cloth moistened with Xylol and wipe dry with chamois.

Use no alcohol on lacquered parts of the instrument, as it will remove this finish. As the latter is for the purpose of preventing oxidization of the metals,

it is important to observe this rule. Parts finished in black are usually alcohol-proof.

To use the draw-tube, impart the spiral motion.

In using a screw driver grind its two large surfaces so that they are parallel and not wedge-shaped, so it will exactly fit in the slot of the screwhead. Turn the screw with a slow steady motion, pressing the screw driver firmly into the slot. No screwhead will ever be injured if these points are observed.

Joint for Inclination. If the joint should become loose so as to prevent the arm being set at any angle of inclination, it should be tightened by drawing up the nut at one or the other side. If the nut has a screw slot, use a properly prepared screw driver, but if two holes, a suitable key should be obtained from the maker. In high grade instruments the axle is generally tapering, and to determine which nut is to be drawn up can only be done by trial.

CARE OF THE COARSE ADJUSTMENT - Special care should be given to keep the coarse adjustment free from dust, as its effect is particularly pernicious. The slides and rack and pinion are necessarily exposed and the lubricant is apt to catch dust and also to gum. The tube should be occasionally withdrawn from the arm and the slides carefully wiped with a cloth moistened with Xylol. Lubricate by applying a small quantity of paraffine oil to a cloth and wiping well over the surfaces, removing the superfluous amount with a dry cloth. The teeth of neither rack nor pinion should ever be lubricated. An occasional cleaning of the teeth with a tooth brush is advisable.

It is advisable occasionally to lubricate the pinion shank on both sides of the arm with a very minute quantity of paraffine oil.

If the pinion works loose from jar incident to transportation or long use, which sometimes occurs to such an extent that the body will not remain in position, increase the friction upon it by tightening the screws on the pinion cover.

FINE ADJUSTMENT - In a general way it may be said that if the fine adjustment ceases to work satisfactorily, the instrument had better be returned to the maker, as it involves the most delicate working and few people are conversant with its construction. There is very seldom any occasion for this, however, if used with reasonable care.

If the fine adjustment does not respond to the turning of the micrometer screw, or if it comes to a stop, it indicates that the adjustment screw has come to the limit of its motion at either end. It should by no means be forced; it should be all times be kept at a medium point.

CARE OF OBJECTIVES AND EYEPIECES - Every outfit should be provided with a camel's hair brush and a well washed piece of linen. On account of its fine texture chamois skin is desirable, but only after it has been repeatedly washed. No dust should be permitted to settle upon lens nor should the finger come into contact with any of the surfaces.

At regular periods unscrew *the eye-lens and field-lens* and clean the inner surfaces.

When not in use objectives and eyepieces should be kept in their receptacles. If objectives are left attached to the microscope either singly or on revolving

nosepieces, leave the eyepiece in the tube so that no dust can enter and settle upon the rear lens of the objective.

Objectives especially should be kept where they are not subject to extreme and sudden changes of temperature, as the expansion and contraction may cause the cement between the lenses to crack.

The systems should never be separated, even if they can be unscrewed, as they are liable to become decentered and dust may enter.

Avoid all violent contact of the front lens with the cover glass. The oil immersion objectives particularly require the best care.

Occasionally examine the rear surface of the objective with magnifier and if dust be present remove with camel's hair brush.

Clean an immersion objective immediately after it has been used by removing the fluid with lens paper.

While cleaning, give the objective a revolving motion.

If the immersion oil should have become thick, or any substance adheres to the surface, it may be removed by using lens paper moistened with Xylol.

EYEPIECE - *Visible defects in the field are* always traceable to impurities in the eyepiece, not in the objective, and are easily recognized by revolving it. Indistinctness in the image or loss of light may be due to soiled or coated surfaces in either eyepiece or objective.

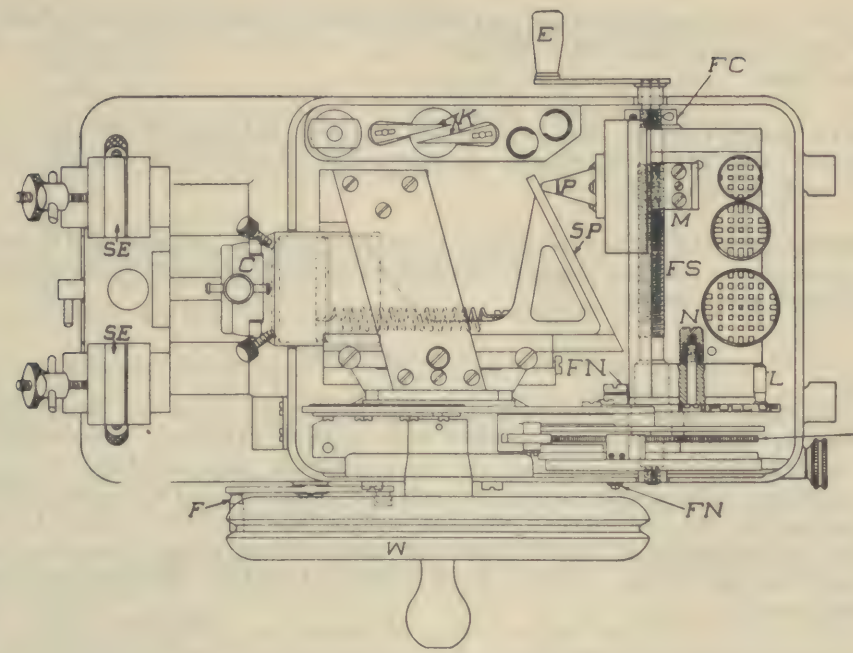
Dust, if on either the eye-lens or field-lens, is apparent as dark, indistinct spots.

To clean the surfaces, breathe upon them and, giving a revolving motion to the eyepiece, wipe with well washed linen and finally blow upon the surface, or use camel's hair brush to remove particles of lint.

If any part of the microscope cannot be brought to a satisfactory working condition by the foregoing instructions, or any part is injured by accident, it should invariably be sent to the maker or to a reliable manufacturer of microscopes.

CHAPTER XII
MISCELLANEOUS

SECTION 5
MICROTOMES



INSTRUCTIONS FOR OPERATING NO. 820 MICROTOME - After removing the paper that is packed into the instrument to protect it from damage in transit, also the wooden block between the feed screw nut tip and the inclined plane, carefully wipe the inclined plane to be sure it is free from dust or grit, and apply to it a thin coating of clean vaseline.

Close the cover and set the feed so that the line indicating the desired thickness of section comes exactly opposite the fixed index line.

Remove the catch F from the handwheel W and the instrument is ready to operate. This catch should always be used to lock the handwheel when the specimen is being trimmed in place. It prevents the specimen from being pushed down and bringing the operator's fingers in contact with the knife edge. A much safer procedure, however, is to remove the knife when working with the specimen.

When the limit of the feed has been reached, the block M pushes against the pin N and disengages the feeding mechanism. When this occurs, the block should be brought back to the beginning of its range by turning the handle E. Care must be exercised not to turn this handle in the direction to produce forward motion beyond the limit of the feed, as the feeding screw may thereby be damaged.

When the mechanism has been automatically shut off, it may be again engaged, after the feed block has been turned back, by simply lifting up the lever L (marked PULL UP) till the pin snaps back into place.

There is a possibility that from considerable use the friction of the feed screw FS and its ratchet wheel RW will be lessened. This will be noticed by the sections sometimes coming thicker than that for which the instrument is set. This lessened friction can be detected by the ease with which the feed screw crank E can be turned. To increase the friction, tighten the friction collar FC against the bracket. If this is not sufficient, friction can also be obtained by slightly

screwing in the square head friction screw FN, shown between handwheel and case and inside screw with slotted head FN. No more than one turn of the friction nut should be made at one time.

Only small quantities of the best grade of thin oil should be used on bearing surfaces (except the inclined plane as mentioned above). A can of this oil is supplied with each instrument.

CARE SHOULD BE TAKEN that all the clamping screws on the knife holder, as well as the eccentric clamping device, should be well tightened to prevent movement of the knife while sectioning.

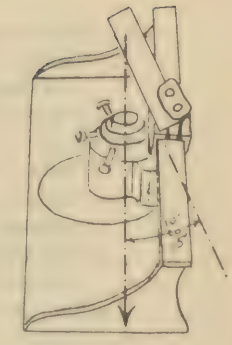
EFFICIENT MICROTOMY

I. HAND SECTIONING - This is convenient and saves the time of imbedding. Plant tissues are better adapted to this method than animal tissues. Considerable skill is required in arranging the material in the microtome and handling the razor when making thin sections. Draw the knife through the material with a slant of 10^o - 30^o from the direction of the cut with a slicing motion and hold the razor so that there is adequate tilt to clear the facet bevel of the cutting edge. Support the tissue in the well of the microtome with a good grade of pith. Wetting the knife and material often helps.

II. CELLULOIDIN IMBEDDED MATERIAL - The celluloidin method is preferable for large tissues and organs, tough or hard material, and delicate tissues that might be injured by heat. It may be the method of choice for delicate objects because the celluloidin holds the structures together permanently as it need not be removed from the sections. It is not possible to form ribbons of serial sections as each section is cut individually. The knife and block should be kept wet with alcohol while cutting except when using the dry methods. Most trade preparations of celluloidin are cellulose nitrate and the slow burning kinds are preferable. The nitrocellulose is dissolved in a mixture of equal parts of 95% alcohol and sulphuric ether.

The knife should slice through the material with a slant angle of about 10^o - 35^o to the direction of the cut and the knife should be tilted more than required for paraffin imbedded material.

1. The chief difficulty comes from trying to cut improperly prepared material. Adequate impregnation of a large organ like a hemisphere of a brain may take a year. Improperly hardened blocks cannot be sectioned successfully. Pressure methods involving heat speed up the process and are available when warming will not injure the material.
2. Lengthwise scratches or splits in the section may be due to:
   a. Nicks in the knife - use a different part of knife or resharpen.
   b. Particles of hard material in the block.
      i. Dust or dirt in the celluloidin stock solution - let stand and use only upper portion after the particles have settled out or filter the stock solution.
      ii. Calcareous or silicious deposits in the material - decalcify or desilicify.
3. Specimen falls out of section, is mushy and soft.
   a. Dehydration was incomplete.
   b. Infiltration incomplete - reinfilter, reimbed and harden.
   c. Harden block if too soft, in chloroform, or a mixture of equal parts of 95% alcohol and glycerine.



4. Variation in thickness of sections.
    a. Loose screws on knife or block holders - tighten all set screws.
    b. Knife holder depressed or raised by the hand while sectioning - hold knife block so as not to move it vertically while cutting.
    c. Knife not tilted enough to clear facet of cutting bevel.
    d. Knife too dull.
    e. Microtome worn and out of adjustment.
    f. Material not hardened properly - cf. 3c.
    g. Slight drying of block between sections.

III. PARAFFIN IMBEDDED MATERIAL - The paraffin method is preferable for sectioning small specimens and is rapid because the sections form a ribbon as they are cut. With hard paraffin thin sections are more readily cut than thick ones and vice versa.

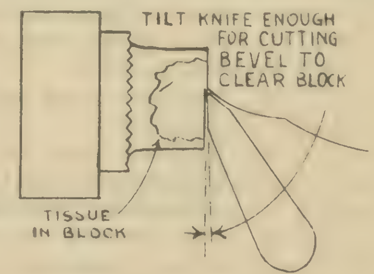
Galligher, A. E., Essentials of Practical Microtechnique (1934, Berkeley, 228 pp.) offers the following suggestions for proper hardness of paraffin:

Thickness of section in μ	2-4	5-7	8-10	12-14	16-20	22-25	25-30
Room temperature °F. for soft 45°C. paraffin				70	74	77	80
Room temperature °F. for 52°C. paraffin	62	66	70	75			

1. Ribbon fails to form.
    a. Room is too cold or paraffin too hard.
        i. Use softer (lower melting point) paraffin.
        ii. Warm knife slightly by blowing the breath on it, or immersing in *warm* (not hot) water.
        iii. Place a desk lamp so that the light and heat fall on the knife and block.
    b. Tilt the knife less.
    c. Cut thinner sections.
    d. Knife may be too dull - resharpen.
    e. Dip block into a softer paraffin and trim so that a thin layer remains on the upper and lower edge of the block.
    f. Unroll the section and hold it lightly against the knife with a camel's hair brush. If the first few sections can be held down, the ribbon will often form and follow.
2. Crooked ribbons.
    a. When sections are wedge shaped the sides of the block are not trimmed parallel.
    b. Edge of block not parallel to knife edge.
    c. Try another part of the knife - sometimes irregularities of the knife edge cause crooked ribbons.
    d. The paraffin at one side of the block may be softer than at the other side, especially if the material has been reimbedded in a paraffin of different hardness - reimbed the material and stir the melted paraffin.
3. Sections compressed, wrinkled and jammed together.
    a. Knife too dull.
    b. Room too warm - cool trimmed block and knife in very cold or ice water immediately before sectioning, or reimbed in a harder paraffin.

c. Knife tilt too slight so facet bevel rubs over block - increase tilt.
d. Knife edge gummed with paraffin - wipe with finger or cotton moistened with xylene.
e. Soak block in water from an hour or two to overnight before cutting.

4. Sections crumble and specimen may tear out.
   a. Material incompletely dehydrated or not properly cleared.
   b. When soft and mushy, material incompletely infiltered - reinfilter and imbed. (Salvage rarely possible if material was incompletely dehydrated.)
   c. Alcohol not completely removed by clearing fluid.
   d. Object too long in paraffin bath or paraffin too hot.
   e. Subject hard and brittle due to clearing fluid. Try toluene in place of xylene or a mixture of toluene and cedar oil.
   f. Try celluloidin imbedding, or a rubber or asphalt mixture with paraffin for fragile material.
   g. Try dioxan method for dehydrating.
5. Split ribbon or lengthwise scratches in ribbon.
   a. Due to nicks in knife - use another part of knife or resharpen knife.
   b. Use less tilt of knife so it will cut rather than scraping.
   c. Knife edge dirty. (*Cf.* 3d.)
   d. Object may be too large for paraffin method - use celloidin.
   e. Hard particles in block may cause scratching.
      i. Dirt in paraffin - filter or decant melted paraffin.
      ii. Crystals from killing fluid (mercuric chloride) when washing was insufficient.
      iii. Calcareous or silicious particles in material - decalcify or desilicify.
6. Knife rings on up stroke and sections are scratched.
   a. Change knife tilt to greater or less degree - tilt must be sufficient to clear facet bevel, but not enough to scrape instead of cut.
   b. Material is too hard.
      i. Soak in water to soften (*cf.* 12d).
      ii. Clearing may be at fault (*cf.* 4e).
   c. A thicker or wedge shaped knife may prevent springing of the edge when cutting.
   d. Material may be too tough for paraffin method - try celluloidin.
7. Sections lifted from knife on up stroke.
   a. Increase knife tilt.
   b. Room too warm or paraffin too soft - try harder paraffin - cooler room; or cool block (*cf.* 3b).
   c. Knife may be dull - resharpen.
8. Sections stick to knife. (*Cf.* also 3 and 4).
   a. Knife edge dirty - (*Cf.* 3d).
   b. Increase knife tilt.
   c. Try a sharper knife.
9. Undulations in the surface of the section.
   a. Tighten all set screws on knife and block holders and see that knife holder is clamped fast to microtome base.
   b. Lessen excessive knife tilt to prevent vibration. (*Cf.* 6c, 12).



10. Scratching noise during cutting.
    a. Material may be too hard, or small regions of material may be hard. (*Cf.* 4c, d, 5e).
11. Sections fly and stick to parts of microtome or other nearby objects, due to static electricity formed from the friction of cutting. This usually occurs only in winter when the air is very dry.

a. Increase humidity of room by boiling water in an open pan, or burn a bunsen burner in the room.
b. Ground microtome to a water pipe with a wire or a chain.
c. Ionize the air by an electrical method. (*Cf.* R. J. Blandau, Stain Tech. 1938, 13: 139-141).

12. Sections vary in thickness or are skipped.
    a. Knife not tilted enough to clear facet or bevel and tissue is compressed until the inevitable expansion gives a thick section.
    b. Some of the clamping set screws on the block or knife holder are not tight or knife holder block not clamped firmly.
    c. Microtome worn through lack of lubrication, or not in adjustment.
    d. Very large blocks or blocks with hard regions may spring knife edge while sectioning - soak block in water to soften, use other methods for softening the material or imbed the celluloidin. The block will soak quicker if the paraffin is trimmed off one side to expose the tissue. Very little water is absorbed, but this process sometimes makes possible cutting hard or tough material.

IV. FROZEN SECTIONS - This is a method for rapid preparation of sections of moderate thickness. Also useful for microchemical studies to avoid the effects of the chemicals in killing fluids.

Fresh material may be cut as soon as frozen, but better sections may be obtained after the tissue has been killed, washed and soaked in a gum syrup. Tissue fragments may be embodied in gelatin before cutting. Material in alcohol should be passed through a series of alcohols to water and fixed tissues should be washed before freezing.

Freeze with moderately rapid gas flow. A small glass tumbler with an opening about the diameter of the freezing head may be held over the tissue while freezing to aid in even hardening.

Test cutting conditions and when the tissue has reached the right hardness cut the required number of sections quickly with an even and rapid stroke. It may be convenient to freeze the material hard and cut when it has thawed to the right stage.

The knife must be cooled to prevent the sections sticking to it. Sections may be removed with a camel's hair brush and placed into distilled water. When using a chisel shaped blade, hold it against the chest or body to brace the arms and make the cut by swaying the body.

Very hard or dense tissues may not be cut at less than 18-20 μ. The average thickness is often 15 μ. Considerable skill is required for cutting thinner sections.

All set screws holding the freezing equipment and knife must be tight to avoid vibration when cutting frozen sections.

GENERAL INFORMATION

V. 1. The rate of cutting influences the sections. Some materials are readily cut with a quick even stroke of the sliding microtome and others cut more readily with a slow even stroke. The rate at which the rotary microtome is turned should be varied until the best speed is found for each kind of material.

2.. Microtomes are precision instruments and will give good service only when properly cared for. Regular lubrication is necessary, dust and dirt should be removed after use and the instrument should be covered when not in use.

3.. For references on microtechnique *Cf.* Spencer Publication C4.

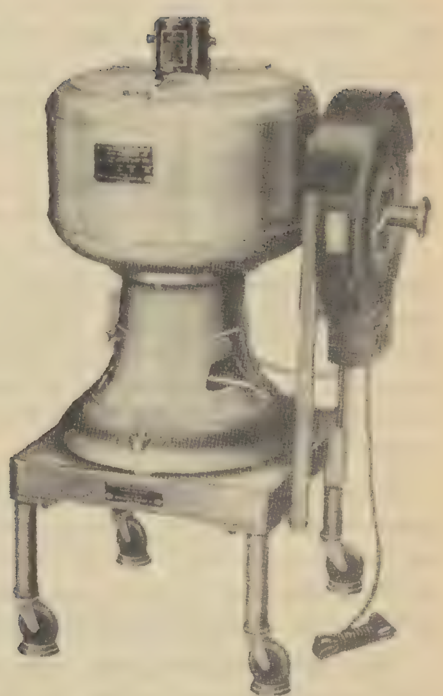
CHAPTER XII

MISCELLANEOUS

SECTION 6

CENTRIFUGES

Type SB with Standard Guard



Type SB and Portable Stand

Care and Maintenance of Centrifuges

— *GENERAL CONSIDERATIONS* —

When a user of a centrifuge reports trouble, the cause or causes will be found, on investigation, in a large majority of cases to be associated with (1) lubrication of bearings, (2) condition of commutator and brushes, (3) balance of load (including all movable parts) and (4) the conditions of mounting the base.

(1) *LUBRICATION:*

If lubrication is perfect, a large percentage of centrifuge troubles will be avoided.

All Size 1 and Size 2 Centrifuges have two bearings only, the Upper Bearing just below the top of the shaft, and the Lower Bearing at the bottom of the shaft.

(a) **Lower Bearings** are similar in all sizes, (See Figs. 2, 4, 6) consisting of a bronze bushing, Nos. 1704 for Type C, 1706 for Type SB and Size 2, pressed into an oil well, with a single steel ball, No. 1728, for taking thrust between two ground steel surfaces, B, at lower end of shaft and bottom of oil well. The lubrication of this bearing is easily taken care of by keeping the side oil cup supplied with best grade of light lubricating oil.

(b) **Upper Bearings, Size 1, Types C and SB** are alike (See Figs. 1, 3) consisting of a bronze bushing, Nos. 1703, 1705, with small felt wick, No. 1726, to carry the lubricant, No. 1709, to the shaft through the length of the bushing, and a grease cup above having a felt washer, No. 1725, in its bottom to draw the lubricant to the supply wick, and a cover, No. 1720, to keep the air draft from blowing the lubricant out of the cup. The lubricant that has been found to be the most satisfactory is supplied by us in compressible tubes and called I.E.C. Lubricant.

Inspection of this bearing for proper control of lubrication should be made monthly.

(Note): To get at this bearing for inspection, the head must be removed from the shaft. This should be easily done, first turning back the set screw in the hub of the head, then grasping the head on opposite sides and pulling up sharply. If the head does not yield readily, it indicates (1) corrosion, or (2) abrasion or roughening of shaft, or slight upsetting of shaft at the angle where the key, K, Figs. 1, 3, 5, is inserted. In these cases the shaft must be driven out of the head. Two persons working together can best do this, proceeding as follows:

Secure a hard wood dowel or brass rod slightly under $\frac{1}{2}''$ d. Let one person grasp the head on opposite sides, pulling steadily up, and the other person, placing the dowel or rod on the top of the shaft, tap downward sharply with a hammer, but not striking hard enough to drive the shaft severely onto the lower bearing against the upward pull on the head. A little well directed and patient work will usually produce the desired result.

When the head is removed examine the hole in the hub, looking toward the light to find the scratches parallel to the axis that indicate the points at which the shaft binds. Then with a fine flat file, draw-filing the shaft at the places indicated, the trouble may be removed. The head should go on and come off easily and yet be a very good fit. (Our testing plug and ring gauges have a difference of diameter of only 0.0005″, so that a little dirt is enough to make too tight a fit.) After filing the shaft, the grease should be taken out of the cup and clean grease applied.

(c) **Upper Bearing Size 2** (See Fig. 5) is an automatic wick oiler requiring high grade fluid lubricating oil. (See Instruction Card accompanying each Size 2 Centrifuge.) Inspection of this bearing for control of lubrication should be made at least twice a year. To get at the bearing for inspection, the head must be removed from the shaft [See (1) (b) (Note) above.]

(2) *COMMUTATORS AND BRUSHES:*

The life of the motor depends largely on attention and good care of these parts.

(a) **Commutators** should have smooth cylindrical surfaces, E. Figs. 2, 4, 6, not scratched or cut into concentric grooves. (The method of segmenting should not be confused with the statement above. There are two methods of making segmented commutators the "flush" and the "undercut." Both are good.)

If they become rough, scratched or grooved, they should be put into good condition again, thus: - (a) If not too badly roughened, fine sandpaper, 0 or 00, but **not** emery cloth, may be used, running the centrifuge at low speed; (b) if markedly cut, the armature should be taken out and the commutator trued up in a lathe. In order to get at the commutator it will be necessary to remove the hand hole covers on Size 1, SB and Size 2, and small plate on Size 1, Type C.

(b) **The Brushes** should be of a composition equivalent to "Henrite." (We have tested out a variety of others but have not found them to be the equivalent of "Henrite.") We stock them in suitable sizes to fit our brush holders, and dealers should carry sufficient stock to meet needs of their customers.

They should fit rather loosely in the brush holders, so that the spring tension will keep them in good contact with the commutator.

When they have worn down so that the springs are nearly in contact with the brush holders, the brushes should be renewed.

It is worth while recommending customers to keep supplied with extra brushes.

(c) **Brush-Release and Brake.** The Size 1, Type SB and the Size 2 Centrifuges are supplied with a brake band, D (Figs. 4, 6), below the commutator and a "brush release" mechanism operated by the same handle as the brake. (The purpose of the "brush release" is to remove the spring tension from the motor brushes, thus allowing the centrifuge tubes to stop more gradually.) It is necessary for the operator to make sure that the "brush release" is not operating when the current is on. If it is, there will be undue sparking, or the motor may not start. It is well, therefore, to make a practice of returning the handle to brush pressure position every time the "brush release" has been used.

> The Brush Release of Size 1, SB, is operated by pulling the handle toward the front of the centrifuge.
>
> The Brush Release of Size 2 is operated by pushing the handle towards the back of the centrifuge.
>
> The Brake, in case of Size 1, SB, is operated by pulling *up* on the handle.
>
> The Brake, in case of Size 2, is operated by pulling the handle towards the front of the centrifuge, and there is a spring that normally keeps the brake sleeve from touching except when held by the hand. In case this works very freely, the spring sometimes snaps the handle back, if let go very abruptly, so that it comes to the "Brush Release" position, which may cause sparking. That, of course, is easily remedied by manipulation when attention is brought to the cause as above stated.

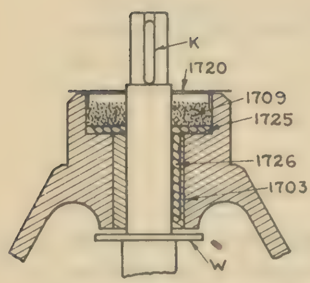


Fig. 1

(3) *BALANCE:*

A reasonably good balance of heads and tubes with their contents, constituting the rotational load, should always be preserved, both for the sake of satisfactory operation and of the mechanical life of the machine.

(a) **Heads** are balanced when made, and except for accident or misuse, should remain permanently in balance.

(b) **Removable Trunnion Rings** are selected in sets suitable for the various heads and should be kept in such sets. The weight in grammes is stamped on each trunnion ring.

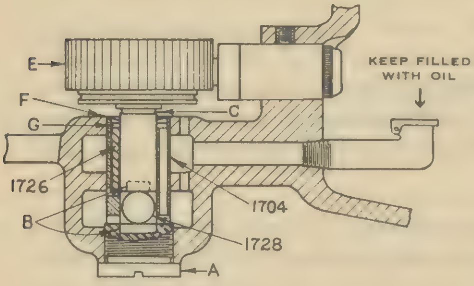


Fig. 2

(c) **Metal Tubes** are selected in sets, and should be kept in sets. When renewal of a tube is wanted, a tube of the same set should be sent to us to match, or the weight in grammes should be given, *excluding the rubber cushion.* Tubes are not marked with the weight.

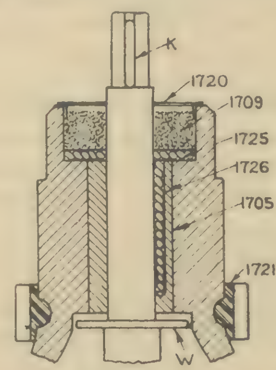


Fig. 3

(d) **Trunnion Cups** are selected in sets. The weight in grammes is stamped on each cup.

(e) A suitable *Rubber Cushion* is furnished with each tube and trunnion cup, which for moderate speeds of the centrifuge is usually sufficient to protect the glass from breaking. For high speeds, it is desirable to use water in the metal tube on the outside of the glass tube, to balance the internal pressure in glass tube and prevent its rupturing.

(f) It is, in general, well to operate centrifuges in best practical balance, giving heed to the above items of instruction. However, *extremely accurate* balance can only be obtained, ordinarily, by giving an undue amount of attention and time on the part of the operator, and that, of course, detracts from laboratory efficiency. Hence, it is desirable to eliminate the disagreeable results of vibration — noise, disturbance of microscopic work, etc. — by mounting it on suitable cushioning material. [See (4) below.]

(g) The Size 1, Type SB Centrifuge was designed so that to a very practicable extent it would be self-balancing. This is provided for by installing the motor flexibly in the base, the motor bracket resting in a soft rubber socket, No. 1715 (Fig. 4), and the housing of the upper bearing being supported flexibly by a molded rubber cushion ring, No. 1721 (Fig. 3).

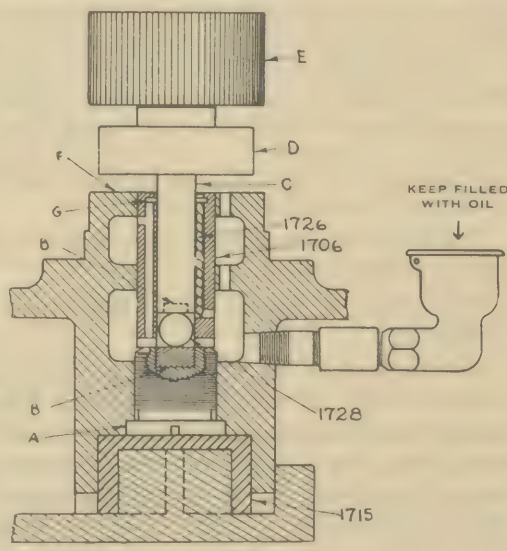


Fig. 4

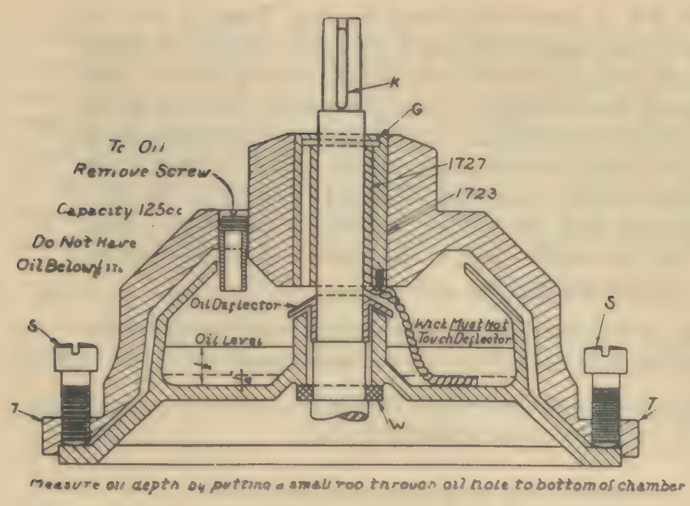


Fig. 5

(4) *MOUNTING:*

The place and method of mounting a Size 1 or Size 2 Centrifuge will be determined somewhat by local conditions.

For convenience of the operator, the top of the centrifuge, cover closed, should usually be from 30″ to 39″ from the floor.

A substantial support should be provided for mounting the centrifuge, such as stout table, bench, iron stand, concrete pier, etc., but in any case it is best not to bolt the base of the centrifuge rigidly to such support, but rather to secure it in a way to allow considerable freedom of the base to vibrate or even wobble on suitable cushioning, such as soft rubber or cork.

Following out this idea, a portable vibrationless iron stand has been developed that combines satisfactory mounting with portability in a very practical way. (See Bulletins C1 and C2 for description and illustration.) These stands are being increasingly ordered for new as well as old centrifuge installations.

— *REPAIRS* —

In case of the sources of trouble indicated in the above items, a little intelligent advice to the customer on the part of the dealer through his salesmen or service men will serve to correct or prevent them. Other difficulties may require actual repairs or renewals, indicated as follows:

(1) *BEARINGS:*

The upper bearings are more subject to wear than the lower bearings, hence will require renewal more often.

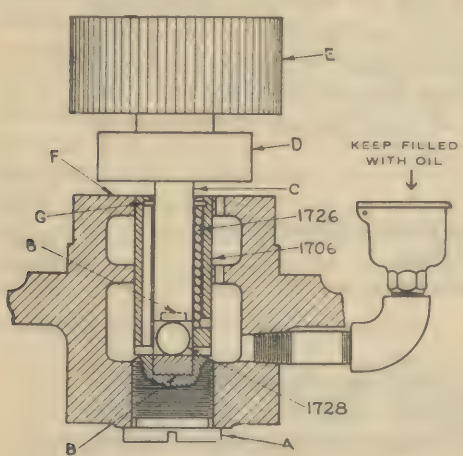


Fig. 6

(a) Size 1, Type C Upper Bearing Renewal:

To get at the upper bearing for renewal, first remove the head from the shaft [See "General Considerations" (1) (b) (Note)] and clean out the grease cup, removing the felt washer, No. 1725 (Fig. 1). Remove centrifuge from its mounting and turn it on its side to drain oil from lower bearing through oil cup. Turn centrifuge upside down, mark motor base and casing in such a way as to insure motor base being replaced in same position. *Remove the carbon brushes*. Remove the three screws securing the motor base to the casing. Disconnect the armored cable and lead wires at rheostat. Lift off motor base, being care-

ful not to lose the steel ball No. 1728, Fig. 2, from the bottom bearing. Then lift out the armature, also being careful not to lose the iron washer W, Fig. 1, on the top end of the shaft. The upper bearing which is in the guard casing is now exposed and the bronze bushing may be pushed or driven out using a hard wood dowel of approximately the same diameter as the bushing and flat on the end. Do not use a metal dowel since it might upset the bronze bushing. The new bushing may then be pushed or driven in in the same manner. It is important to see that the bushing is right end up. The open end of the wickhole should be at the top. The face of the bushing at the top end should be flush with the finished face of the iron housing when finally in place. The wick, No. 1726 (Fig. 1), should come to the upper end of the bushing, No. 1703, so as to be in contact with the felt washer, No. 1725.

While the machine is thus dismantled, it would be well to take out the ball from the lower bearing and replace with new 7–16″ d., No. 1728 ball, if the old one shows wear.

Be sure the ball is in place in the lower bearing when reassembling.
Be sure the washer, W (Fig. 1), is in place when reassembling.
Reassemble in reverse order.
Return felt washer, No. 1725 (Fig. 1), and refill cup with lubricant, No. 1709.

(b) **Size 1, Type C Lower Bearing Renewal:**

If the bushing of the lower bearing needs renewal, proceed as follows:

Remove head from shaft [See General Considerations (1) (b) (Note)]. Remove cover, No. 1720 (Fig. 1), and clean out the grease cup, removing the felt washer, No. 1725. Turn the centrifuge on its side and drain the oil from the lower bearing through the oil cup. Then invert Centrifuge and remove screw plug A (Fig. 2) at bottom bearing.

(Note): The screw is large in diameter and is shellacked when originally assembled. It will require a very heavy wide screw driver and probably a wrench used as handle in order to get pressure enough to start the screw and turn it back. Also the machine will have to be held firmly. Be careful not to injure the slot in the head of the screw plug.

The steel ball may now be removed. Then disconnect the armored cable and lead wires at the rheostat and remove the carbon brushes from the brush holders. Remove the cap screws from the motor base, marking the base and casing so as to be sure and replace in the same position. Remove the base and rest it on its flange on a blocking of wood in such a manner as to protect the field coils and the machined surface of the base. Drive out the bronze bearing bushing, No. 1704 (Fig. 2), (using a hard wood dowel rather than a metal rod to avoid injury to the metal. The dowel should be approximately the same diameter as the bushing and flat on the end). Reverse the motor base and drive in the new bearing bushing from the inside, using the same precautions. The bushing should go in so that its end face is flush with the finished surface of the motor base, F (Fig. 2). It is important to see that bushing is right end up. The concentric grooved end should be at the top. See that the wick, No. 1726, comes only up to the lower edge of the concentric groove, G, near the top of the opening. Reassemble motor in reverse order.

Be sure that the steel ball is in the bearing.
Be sure that the iron washer, W (Fig. 1), is in place when reassembling.
Fresh shellac should be used to coat thread of the screw plug.
Replace felt washer, No. 1725 (Fig. 1), and refill cup with lubricant No. 1709.

(c) **Size 1, Type SB Upper Bearing Renewal:**

To get at the upper bearing for renewal, first remove the head from the shaft [See above. "General Considerations" (1) (b) (Note)]. Remove cover, No. 1720 (Fig. 3), clean out the grease cup removing the felt washer, No. 1725 (Fig. 3). Remove enclosing case, secured

by three cap screws through the top of the base. Remove the four screws from the flange of the top cap containing the bearing and take off the cap. Place cap on smooth bench or wood block, and push or drive out the bronze bushing No. 1705 (Fig. 3), and replace new bushing, using hard wood dowel of approximately the same diameter of the bushing instead of metal to avoid upsetting metal of the bushing. It is important to see that bushing is right end up. The open end of wick hole should be at the top. See that the round wick, No. 1726 (Fig. 3), is in its place extending throughout the length of the hole and flush with the upper face of the bushing, so as to be in contact with the felt washer, No. 1725.

While the machine is thus dismantled, it is easy to take out the armature, first removing the carbon brushes. Then the steel ball in the lower bearing may be readily removed by using a magnetized steel rod, and if the ball shows wear, replace with 7-16″ d. steel ball, No. 1728.

Be sure the ball is in place in the lower bearing when reassembling.

Be sure the washer, W (Fig. 3), is in place when reassembling.

Reassemble in reverse order.

Return felt washer, No. 1725 (Fig. 3), and refill cup with lubricant, No. 1709.

(d) **Size 1, Type SB Lower Bearing Renewal:**

This should be considered a major operation, since it involves disconnecting and reconnecting six wire leads from the motor to the terminal connection block and three leads at the brush holders. Do not attempt it unless necessary and unless sure of doing it right. Operation as follows:

Remove head from centrifuge shaft [See "General Considerations" (1) (b) (Note)]. Remove enclosing case, secured by three cap screws through the top of the base. Remove cover, No. 1720 (Fig. 3), and clean out grease cup, removing felt washer, No. 1725. Remove cover of terminal box, and the connection plate. Disconnect, one by one, the wires, withdrawing them from the terminal block, *and suitably tagging each as it is taken out.* The motor may now be lifted out of its rubber lined socket at the tripod base, and taken to the work bench. Remove armature, D, E (Fig. 4), and steel ball, No. 1728 (Fig. 4) from lower bearing. Remove screw plug, A, (Fig. 4) from cast iron bracket at bottom. [See "Repairs (1) (b) (Note)".] Disconnect the lead wires at the brush where there are two, one at a time, returning the screws so as to keep the insulation in place, then disconnect the lead wire at the other brush. Remove the carbon brushes. Do not loosen or change the position of the brush holder ring. Remove lower end bracket secured by four cap screws, marking the parts so as to ensure replacement in same position. Rest the machined flange of the inverted bracket on smooth wood bench or blocking and drive out the bushing, No. 1706 (Fig. 4), of the lower bearing (using hard wood dowel, instead of metal rod. The dowel should be approximately the diameter of the bushing and flat on the end.) Reverse the bracket and drive in the new bushing from the inside, using the same precautions. The bushing should go in so that its end face is flush with the finished surface of the bracket, F (Fig. 4). It is important to see that bushing is right end up. The concentric grooved end should be at the top. See that the wick, No. 1726, comes only up to the lower edge of the concentric groove near the top of the bearing, G (Fig. 4).

Reassemble motor in reverse order.

Be sure that the washer, W (Fig. 3), is in place when reassembling.

Be sure that the steel ball, No. 1728, is in the bearing.

Fresh shellac should be used to coat the thread of the screw plug.

Return felt washer, No. 1725 (Fig. 3), and refill cup with lubricant, No. 1709.

(e) Size 2 Upper Bearing Renewal:

Remove head from centrifuge shaft. [See "General Considerations" (1) (b) (Note)]. Remove the six cap screws S (Fig. 5), that secure the top cap containing the bearing bushing, No. 1727, and use two of these screws at the holes, T, to start the cap off. Place cap on a smooth wood block or bench, right side up, and drive out the old bearing bushing and drive in the new one (using a hard wood dowel instead of a metal rod. The dowel should be approximately the diameter of the bushing and flat on the end.) It is important to see that bushing is right end up. The concentric grooved end should be at the top.

Reassemble in reverse order making sure that the wick is properly adjusted to dip into the oil of the oil well and to clear the oil deflector, and coming up only to the lower edge of the concentric groove, G (Fig. 5).

(f) Size 2 Lower Bearing Renewal:

Remove head from centrifuge shaft. [See "General Considerations" (1) (b) (Note).] Remove the top cap as in (e) above. Remove the oil well. Remove the carbon brushes from the motor. Remove the armature. Drain the oil from the lower bearing and oil cup. Turn the centrifuge upside down and recover the steel ball, No. 1728, as it rolls out. Remove the screw plug at the bottom bearing [See "Repairs (1) (b) (Note)"]. Disconnect the lead wires at the brush holders, one at a time, and return the screws to hold the insulation in place, *tagging the wires to insure return to proper places.* Remove the four cap screws securing the lower bracket and take off the bracket. Place it on a smooth wood bench or block, resting it on the machined flange. Drive out the bushing (using a hard wood dowel. The dowel should be approximately the diameter of the bushing and flat on the end.) Reverse the bracket and drive in the new bushing from the inside. It is important to see that bushing is right end up. The concentric grooved end should be at the top. The end face of the bushing should be flush with the finished surface of the bracket, F (Fig. 6). See that the wick comes only up to the lower edge of the concentric groove, G, near the top of the bearing. (Fig. 6.)

Reassemble motor in reverse order.

Be sure that the steel ball is in the bearing.

Be sure that the "oil deflector" (Fig. 5), is in place on the shaft when reassembling.

Fresh shellac should be used to coat the surface of the screw plug.

(2) *ARMATURES:*

If armature trouble is serious — short circuit; burnt out; used up commutator — the most practical remedy is replacement with new one. For procedure of removal of Size 1, Type C, see "Repairs (1) (a);" of Size 1, Type SB see "Repairs (1) (c);" of Size 2 see "Repairs (1) (f)."

(3) *FIELDS:*

Fields seldom need renewal. In case they do, it is usually necessary to return the motor to the factory, and in any case communicate with the manufacturer.

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